THE ILLUMINATING ENGINEER

THE JOURNAL OF

GOOD LIGHTING

Official Organ of the Illuminating Engineering Society

FOUNDED IN LONDON 1908

Edited by
J. STEWART DOW

LIGHT LAMPS FITTINGS AND ILLUMINATION

OIL GAS ELECTRICITY ACETYLENE PETROL-AIR GAS ETC.

Vol. XXI | March, 1928 | Price NINEPENCE
Subscription 10/6 per annum, post free.
For Foreign Countries, 15/- per annum.

EDITORIAL AND PUBLISHING OFFICES:
32 VICTORIA STREET, LONDON, S.W. 1.
Tel. No.: Victoria 5215

A Specification for Illuminating Glassware

THE issue of the British Standard Specification for Translucent Glassware Illumination Fittings* has been awaited with keen interest. Its preparation must have involved considerable care, and it affords yet another instance of the excellent work that the B.E.S.A. is doing in connection with illumination.

We recall many years ago pointing out in this journal the vagueness attaching to such terms as "translucent," "diffusing," etc. The variety of glassware now included under the description "translucent" is still considerable, but so-called decorative glassware is ruled out. "Diffusing power" does not seem to be actually defined in the specification. We believe that some years ago it was proposed to express this quantity in terms of the ratio of the brightest to the least bright region of the luminous surface of the glassware in actual use. Possibly this method has proved impracticable. In the specification it is prescribed that, except when otherwise specified, "the brightness shall be reasonably uniform, and there shall be no pronounced dark or light patches, arising from lack of uniformity in the material." It is also stated that "the diffusing power of the material shall be such that the outline of the filament or other light source shall not be visible when the fitting is viewed from any direction making an angle of less than 45° below the horizontal." Under the same conditions the brightness shall not exceed five candles per square inch.

Most people, we imagine, would agree that glassware meeting these conditions might properly be described as "diffusing," and would possess a degree of diffusing power quite sufficient for all ordinary cases of interior lighting. The method of measuring brightness is described in an appendix. It is suggested that a photometer of the detachable test-plate type should be used, the instrument being pointed directly at the lighting fitting. The brightness in candles per square inch can then be derived, by means of the familiar formula, from the reading of the instrument in foot-candles. This is doubtless the easiest way of making the measurement, provided the photometric instrument answers requirements. In a laboratory the photometer may be brought sufficiently close to the glassware to ensure that the aperture in the field of view is completely covered by it. This condition, however, is not so easily secured under actual working conditions—e.g., in a factory or a large office where the distance away of the fittings may be considerable. It will also be observed that a brightness of 5 candles per square inch is equivalent to an illumination of the order of 2,000 foot-candles, so that the range of the instrument must be considerable and dark glasses appear necessary.

The method of testing "performance," i.e., the ratio of the luminous output of the fitting to that of the source is also outlined in an appendix. We have no doubt that most people will prefer the photometric integration method for this purpose. The tolerance allowed is ± 15 per cent., which is not at all surprising in view of the very large variations in absorption of light sometimes encountered, even in glassware presumably of the same type.

The clauses under the heading of "Dimensions" are among the most important in the specification. It is specified that the type and maximum rating of the light source to be used with a given fitting should be clearly marked on the glassware by the maker, and that, where the position of the light source within the fittings is capable of adjustment, the best position should be clearly indicated. These are most useful clauses. It is further specified that glassware shall easily admit the lamp or lamps with which it is to be used—a fairly obvious requirement, but one which experience suggests is by no means superfluous! Details of dimensions of necks of fittings are given, and it is understood that in the case of electric lamps the bulb dimensions shall be those given in the British Standard Specification (161-1925).

This question of the relative dimensions of glassware and lamps is an exceedingly important one, both to manufacturers and to users of lighting appliances. We hope that one effect of the issue of the specification will be to maintain close relations between makers of lamps and fittings, so that there may be mutual consultation before alterations in dimensions are made.

The Specification prescribes a test of "heat resistance" based on immersion of the heated glassware in water. There is also a clause guarding against internal wiring becoming unduly heated, and a general requirement that glassware shall not unduly deteriorate or discolour under normal conditions of use.

* British Standard Specification for Translucent Glassware Illumination Fittings for Interior Lighting; No. 324-1928. Obtainable from the British Engineering Standards Association, 28, Victoria Street, London, S.W. Price 2s. net; post free, 2s. 2d.

Traffic Signs and Signals

THE paper on the above subject, read by Mr. W. J. Jones, at the meeting of the Association of Public Lighting Engineers on February 21st is, we believe, one of the first in this country to deal at all fully with traffic signs and signals and their lighting requirements. There is already in use quite a variety of such signs, serving for purposes of direction, as warnings of danger and as guides to traffic. The design of such signs in various districts is far from uniform, and practice in regard to illumination differs considerably. In some areas no attempt is made to light up traffic signs, in others the sign is incorporated as part of the street-lighting equipment. This last expedient, whilst better than leaving signs unilluminated, is not ideal. The best plan, doubtless, where feasible, is to treat the illumination of signs as a special branch of public lighting.

If traffic signs are left unlighted their effectiveness is largely lost during night time—often the very period when they are most needed. But the desirable brightness of the sign deserves careful study; an unduly brilliant effect may actually prove a source of danger. Generally speaking, a degree of brightness which is quite adequate in rural areas may be unsatisfactory in cities, where it has to compete with the brilliancy of street lamps. Mr. Jones presents some interesting data on the visibility of signs. There is room for further experiment on the relation between brightness and visibility. Another fact not generally appreciated is that the distance at which a sign is visible depends on the speed of travelling—according to the author, it depends on the square of the speed. The position allotted to a sign, as well as its design, is likewise important. Thus a low mounting height is not desirable owing to the danger of confusion with rear lamps of cars; for the same reason we believe that there is a strong tendency in the United States towards the adoption of orange, in place of red, for the colours of " caution " signals. There is also the question of the value of " flashing " devices in order to render a sign conspicuous. The effectiveness of an intermittent light as compared with a steady one seems to have been confirmed by tests in America; but the method needs to be used with discretion, for the multiplication of winking lights in ordinary thoroughfares is not entirely a happy tendency. Lastly, there is the question how far automatic luminous control of traffic, as developed in the United States, is applicable to towns and cities in this country.

All these considerations led to the resolution which terminated Mr. Jones's paper: " That a Committee be set up forthwith, representative of all interests, to consider the question of traffic signs and signals, with a view to making recommendations for their improvement as regards effectiveness, and to deal further with the question of standardization."

This proposal was adopted. The function of the Committee will no doubt be to prepare the way for ultimate standards to be framed, with the co-operation of the British Engineering Standards Association, the Ministry of Transport, and other bodies concerned. Evidently standards, in order to be effective, should receive official endorsement. The three problems, public lighting, traffic signs and signals, and motor headlights are intimately associated, and it is probable that the Ministry of Transport will eventually have to deal with all of them.

The co-operation of scientific bodies interested in these problems should be enlisted, so that they may all be dealt with on a national rather than a parochial basis.

The Home Office Industrial Museum

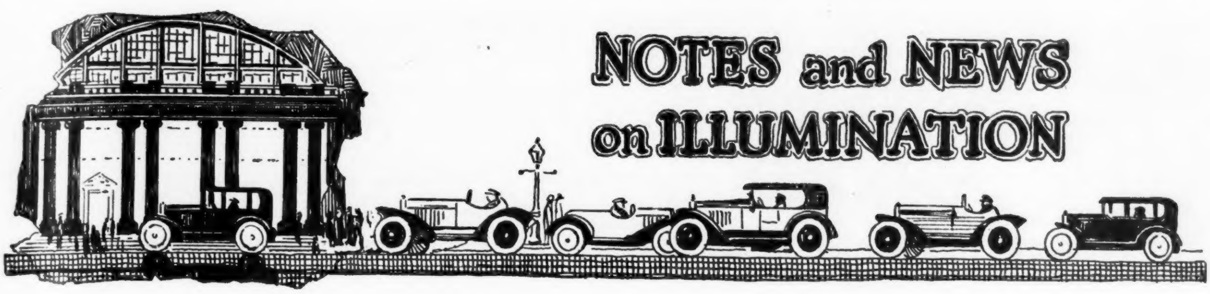
THE visit of members of the Illuminating Engineering Society to the newly opened Home Office Industrial Museum (see p. 77) last month was a most interesting experience. It was a revelation to many of us to find what a variety of up-to-date machinery is installed, and to benefit by the exceedingly able and lucid expositions of Mr. Murray and his staff. One is not surprised to learn that the Museum, the only one of its kind in this country, is already coming to be regarded as a permanent source of information, even by experts on industrial machinery.

Whilst the main purpose of the Museum is to illustrate methods and appliances which aid the safety and health of industrial workers, the actual machinery is itself full of interest. The lighting arrangements and exhibits naturally receive special attention in Mr. Weston's introductory address. Their inclusion is a gratifying recognition of the value of good illumination in the interests of health and safety. The general lighting arrangements are typical of modern methods, and the special section in the basement is designed to illustrate fundamental principles and the results of departure from correct methods. We are betraying no secret when we mention that the inclusion of lighting as an essential element in this exhibition was due largely to the late Mr. Leon Gaster, who took a keen interest in the planning of the Museum. We should also like to take this opportunity of recording the very valuable services rendered in this connection by Mr. D. R. Wilson, the President of the Illuminating Engineering Society. A word of recognition is also due to several of the leading firms in the lighting industry who presented the lamps and lighting appliances that are used.

As Mr. Weston explained in his address, this section of the Museum is not regarded as complete. Modifications and additions will be made as and when required. Whilst, as a whole, these demonstrations seem excellently adapted to their purpose, there are a few little additions one might suggest. We should, for instance, like to see a specimen of the most widely used type of artificial daylight, i.e., that based on correction of light by means of a special glass filter, added to the exhibit bearing on colour-matching. The range of general lighting fittings, already comprehensive, will also naturally require additions as new and improved types are introduced, and this revision should be fairly frequent. Well-designed adjustable local units might also be more fully represented. Illumination is developing so rapidly that exhibits under this head require frequent revision. Some of the present exhibits reflect the excellent work already done by the Illumination Research Committee. In a few years time there may be other investigations equally deserving of illustration.

The general lighting of the Museum is in accordance with the best modern practice, both gas and electric units being represented, and the order of illumination provided is considerably in excess of that usually provided in such buildings. The lecture theatre is also well equipped in this respect.

In conclusion, we should like to remind our readers that whilst the afternoon is set aside for visits by special parties, the Museum is open to the public during the mornings. No doubt such members of the Society as were unable to attend on February 15th will gladly take advantage of this facility.



The Illuminating Engineering Society

RECENT AND FORTHCOMING EVENTS.

We give elsewhere a brief account of the visit of members of the Illuminating Engineering Society to the Home Office Industrial Museum, on February 17th—an event which was originally arranger for the previous month but was postponed owing to the sudden death of Mr. L. Gaster. The visit proved to be most instructive and enjoyable—one's only regret being the absence of Mr. Gaster, who had taken such a keen interest in the lighting of this museum. The other event of the past month was the visit, on February 28th, to the E.L.M.A. Lighting Service Bureau, where the new arrangements for demonstrations were publicly exhibited for the first time. Much interest was expressed in the ingenious series of models of factories, schools, shops, etc., showing good and bad methods of lighting. We shall deal with this visit, and with Mr. Bush's address, in our next number. The next item on the programme is that arranged for March 13th, when a paper is to be read by Dr. S. English dealing with the manufacture and properties of glass and their application to illuminating engineering. On this occasion members will be the guests of Holophane Ltd., at Elverton Street, Westminster. The Society is thus again following their practice of adopting different meeting-places, which adds a spice of variety to their gatherings.

Always Something New!

There is nothing that helps more to impress on one the continuous progress being made in the application of artificial light than a tour of the streets of London. Visitors from abroad report that many of our main streets have become quite different places by night, owing to the general development of luminous signs and advertising devices. Whilst, in regard to magnitude of effort, London may never rival some of the great American cities in this respect, there can be no question that many of the devices in London's streets show considerable skill and artistic effort. We referred last month to the ingenious "Banjo Sign" outside the London Pavilion. Equally interesting is the gigantic *Daily Mail* Free Insurance poster in the Strand, adjacent to the Bush Building. By the aid of duplicate series of lamps of different colours, playing on the poster, the words are made to appear and disappear in succession. The method, of course, is not new. It depends upon the artful combination of the colour of the light and the colouring adopted for the wording and background of the poster. The same device has been not infrequently used for stage transformations, but we believe that it is the first time that it has been used on such a large scale for an outdoor luminous sign. One of the most striking developments during recent years has been the increasing use of luminous signs for advertising entertainments. In some cases the illumination received from such devices adds very considerably to the available illumination—a striking instance being the light derived from the large sign outside the Tivoli Kinema Theatre, in the Strand. Other less striking, but in their way equally interesting, luminous devices may be seen in Piccadilly and elsewhere. It is particularly gratifying to note the tendency of leading sign-designers to rely on originality and artistic skill rather than mere brilliancy. Generally speaking, the luminous sign of to-day is much more interesting and undoubtedly less offensive than its predecessors.

"Licht-Arkitectur"

We believe that the coining of this phrase, which is used in Germany to describe light effects which play an essential part in architectural schemes, is due to Prof. Teichmüller, whose ideas have been expressed in an interesting pamphlet published last year. But this idea, which is gaining increasing recognition, is not confined to any one country. It was strikingly illustrated at the Exhibition of Decorative Art in Paris a few years ago, and instances are to be seen in London to-day. We recall a motor-car showroom adjacent to Piccadilly where the lighting is effected by concealed sources mounted in decorative stone receptacles moulded on to the wall and blends completely with the general austere style of decoration. One might also mention the lighting in the Civil Service Stores in the Strand as illustrating Dr. Teichmüller's ideas. In this case the lights are concealed amidst plates of lemon-tinted diffusing glass, mounted on pillars and harmonizing with the colours of the window glass. (Incidentally some excellent examples of concealed lighting of show-cases are to be seen in the ground-floor area of this store.) Passing along Oxford Street again one is struck by the increasing use being made of floodlighting. One might mention the treatment of the upper story of Bourn & Hollingworth's building as particularly striking; other instances might be mentioned of the floodlighting of upper regions so as to detach them from the rest of the building and emphasize its magnitude. The cornice arrangement adopted in the case of some new buildings is obviously convenient for floodlighting. One hopes that this is an indication that in future floodlighting possibilities will be considered when the plans of commercial buildings are being designed.

The Passing of the Lighthouse

Under this title *The Daily Express* comments on Admiral Clarke's recent paper before the Royal Society of Arts, in which he emphasized the important rôle played by modern wireless methods in navigation. It is possible that such methods may replace, to some extent, the historic method of lighting our coasts—that the navigators of the future may listen instead of look. One fancies, however, that for some time the two methods will continue to be used to supplement each other. We have a parallel case in aerodromes, where the beacon is used to guide the pilot from afar, but the landing cable, carrying an alternating current of specified frequency, may prove most effective in the final stage of directing him to the alighting place. Incidentally Admiral Clarke alluded to Trinity House as the oldest shipping organization in the Kingdom. Its serious work on behalf of shipping commenced in the days of Queen Elizabeth, when small beacons were put up and dues were levied from the ships benefiting therefrom.

Electrodeless Discharge through Gases

The Council of the Physical Society announces that the thirteenth Guthrie Lecture is to be given by Sir Joseph Thomson, O.M., F.R.S., on "Electrodeless Discharge through Gases." The lecture will take place on Friday, March 9th, 1928, at the Imperial College of Science and Technology, South Kensington, commencing at 5 o'clock. No tickets are required.

Ten Years of Illuminating Engineering in Japan

It is interesting to observe that whereas our own journal has just celebrated its twentieth anniversary, a special tenth anniversary edition of the journal of the Illuminating Engineering Society in Japan has just been issued. This is a bulky publication, containing over 500 pages, and illustrates the progress of the movement in the Far East. We take this opportunity of congratulating the Japanese Illuminating Engineering Society on the conclusion of ten years of existence. The introductory pages are occupied by portraits of Presidents and past Presidents, amongst whom we notice Dr. Yamakawa, who was President during the four initial years (1916–1919). We have a keen recollection of a visit of Dr. Yamakawa to this country, and of the interest he expressed in illuminating engineering here. We may next notice a very good feature in this number —the presentation of the index in English and Japanese in parallel columns. We hope that this procedure will become a regular practice. We may also note another step which is useful in enabling English readers to appreciate what is being done by the Japanese Illuminating Engineering Society—the review contributed by Mr. S. Seki, in English, of researches and experiments conducted in Japan during the past ten years. These researches evidently cover a wide field. Whilst some of them may appear somewhat theoretical and abstruse one is impressed by the amount of original work that is being done. One other item we may single out for special mention—the illustrated description of an "Illumination Exhibition" held in Nagoya last year. The display was intended to popularize modern practice in illumination. There were demonstrations of good and bad lighting which recall those conducted by the E.L.M.A. Lighting Service Bureau in this country, but there is an Eastern touch about some of the pictures which is quite distinctive. One might mention, for example, the pleasing form of "Kasugo Toro" (dedicatory lantern) and a charming picture of a Japanese lady in a room designed to illustrate "tranquillizing effect." This exhibition, which was held in the Commercial Museum of the Aiti Prefecture, included a representative series of models designed to illustrate the historical development of illumination in Japan. It is stated that about [illegible]0,000 people visited the exhibition, which should thus have had a considerable educational effect.

Local Lighting in Factories

In an article on industrial lighting in *L'Eclairage*, the new lighting journal edited by Mons. Ch. Huaulx, in Brussels, it is accepted that for some forms of very fine work adjustable local units are necessary, but they should be used as a supplement to the general lighting, not as a substitute. The point to be noted, however, is that such local units require particularly careful design; otherwise they may be worse than useless. Needless to say the source of light should be screened completely from the eyes of workers. But in addition the design of the reflector used needs careful study in order to secure even illumination free from striations, and the position assigned to units is also of importance, as so much depends on the direction from which the light comes. In certain operations, e.g., engraving on metal, it is found that workers often insist on an adjustable unit, because they desire to vary the angle at which light strikes the surface of the material. In any case, it is remarked, the essential point to bear in mind is that the lighting conditions should be designed to meet the needs of the work (not in accordance with general principles, good in themselves, which have not a universal application). It will often be found, if the ideas of the worker are closely examined, that this choice of some system is not based on caprice, but on the intuitive recognition of some factor which he finds it difficult to express in words. It is the duty of the illuminating engineer to clear up and give expression to such needs.

International Illumination Commission

MEETING IN THE UNITED STATES.

We understand that the meeting of the International Commission on Illumination will this year be held in the United States, and that arrangements are being made for British representatives to leave by the White Star liner "Pennland," on August 25th. This will be the first time that the Commission has met in America, where the illuminating engineering movement may be said to have first been originated. Those who are able to attend the gathering will be specially fortunate, for the interest of this visit does not need to be emphasized. It is anticipated that all the chief European countries will send delegates, and we sincerely hope that this country will also be strongly represented. We have often urged the importance of British experts on lighting taking part in deliberations abroad, and the forthcoming meeting will be a specially important one.

Lighting on the Sydney Underground Railway

We have received from Mr. A. Turnbull, one of the members of the Illuminating Engineering Society in New South Wales, some notes on the lighting of the Sydney Underground Railway, with which he is associated. We are also promised some illustrations of this installation, taken entirely by the artificial lighting provided, so that we shall be dealing with this matter more fully shortly. In some respects the lighting arrangements resemble those on the London Tube system, but there are several distinctive features; for example, in the arrangements made for lighting subways. Generally speaking, the standard arrangements will probably be made for the illumination of all the Sydney underground stations. There is, however, a pleasing touch about the special fittings adopted for the St. James' Station. This station derives its name from the historic church in the adjacent Queen's Square, and accordingly the fittings have a certain ecclesiastical character.

The Lighting of Railway Level Crossings

The lighting of railway level crossings has been the subject of much discussion abroad. In general, such crossings are indicated by the new international warning sign, which consists of a three-cornered screen with a red border, and bearing in the centre the picture of a locomotive. Such signs, however, are obviously of no value by night unless illuminated, and even then they are apt to be eclipsed by mist or fog. On some German railways, according to *Licht und Lampe*, a supplementary device is now being adopted. Herr D. Klöters described a special lighting unit designed to illuminate the entire length of the level crossing strongly and evenly, so that its general nature cannot fail to be perceived by the motorist.

TECHNICAL SECTION

COMPRISING

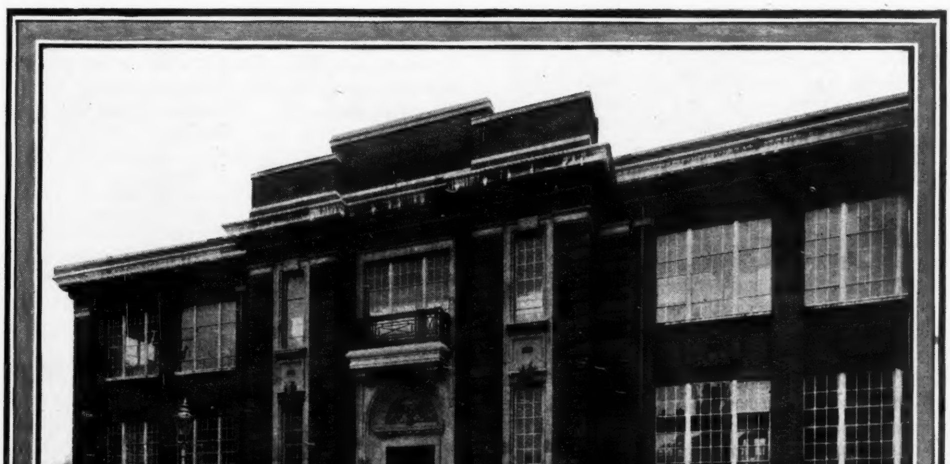
Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

A Visit to the Home Office Official Industrial Museum

ON Friday, February 17th, a party of members of the Illuminating Engineering Society paid a visit to the Home Office Industrial Museum (Horseferry Road, Westminster), which is the only one of this kind in the country (perhaps also in the world). There were also present a number of representatives of the technical press and of the British International Association of Journalists.

After visitors had assembled in the lecture hall, where light refreshments were provided, a short introductory address outlining the chief objects of the museum was given by Mr. H. C. WESTON (Investigator to the Industrial Fatigue Research Board and the Illumination Research Committee).



A General View of the Home Office Industrial Museum, Horseferry Road, Westminster, S.W.1.

Following the address, a few remarks were made by Mr. J. S. DOW (Hon. Secretary), who explained that the President had asked him to say a few words thanking Mr. Weston for his paper. He also wished to propose a cordial vote of thanks to the Home Office Factory Department for granting facilities for the visit, and to Mr. Murray and his staff for the trouble they were taking in showing the party round. After this vote of thanks had been passed with acclamation the party were divided into three groups and were conducted round the museum. Keen interest was expressed in the excellent display of machinery, fitted with appliances desirable in the interests of safety and hygiene. As the machinery can be set in motion, and much of it is of a novel and special character, this in itself formed an interesting display, and it was a great advantage to be conducted by the staff of the museum, who could explain the working of each piece of apparatus and the manner in which operators were safeguarded against danger or possible injurious effects of their work.

The museum, as a whole, is excellently arranged, and the exhibits are illustrated by many diagrams and printed descriptions. To members of the Illuminating Engineering Society the display of lighting exhibits in in the basement naturally made a special appeal. Whilst most of these deal with simple and fundamental points, they are all the more effective as a demonstration to the general public.

The adjacent lecture theatre is also admirably equipped. Here again special attention has been devoted to the lighting, the general illumination being supplemented by special lighting for the benefit of the lecturer and his demonstrations.

On the next page we are reproducing Mr. Weston's paper, which deals particularly with the lighting exhibits.

The Home Office Industrial Museum

By H. C. WESTON

(Investigator to the Industrial Fatigue Research Board and the Illumination Research Committee).

The establishment of the Home Office Industrial Museum was decided upon before the war, and the building, though erected then, has only been equipped during the past two years. The museum is intended to be a permanent exhibition of the best methods, arrangements and appliances for ensuring the safety, health and welfare of the human element in industry, and new exhibits will be included from time to time as they become available.

The museum, which is the only one of its kind in this country, is open to the general public in the mornings, and is available in the afternoons for visits by those who are directly concerned with problems of safety, health and welfare in industry. The floor space available for exhibition in the gallery and on the ground floor is approximately 10,000 square feet, while in the basement a lecture hall is provided, together with rooms devoted to ventilation and lighting. It is hoped that the museum will be of interest and service not only to employers and workers but also to designers of factories and machinery, medical practitioners who are concerned with industrial diseases, welfare workers, inspectors of factories, and all who are interested in the improvement of industrial conditions.

So far as lighting is concerned, in addition to the exhibits contained in the room devoted to the demonstration of the principles and methods of illumination, the lighting installation throughout the whole museum is itself an interesting exhibit. The installation has been planned to provide an initial illumination of 15 foot-candles, except in the lecture hall, where the illumination is 7.5 foot-candles. All the fittings used, including switches, fuse boards, plugs, etc., like most of the exhibits in other sections of the museum, have been lent by various manufacturers, and the cost of equipping the museum has therefore been small. For the illumination of the bays under the gallery on the ground floor of the museum reflector-refractor fittings containing 300-watt gasfilled lamps are used, while five 1,500-watt gasfilled lamps with R.L.M. reflectors are mounted close to the glass roof of the well, and illuminate the central floor space. The gallery is mainly illuminated by superheated gas units, with clusters of nine mantles, each unit being designed to give about 27,000 lumens. The basement and offices are electrically lighted, and certain of the machines exhibited are provided with local lights. In the gallery there is an exhibit of safety electrical equipment, and, in the welfare section, a small artificial daylight window.

The lighting room is provided with a number of cabinets containing exhibits which are largely self-explanatory. The main objects of the exhibition are to illustrate the first principles of lighting, to show the relation between the nature of the work and the amount and kind of illumination required, and to draw attention to certain conditions found in factories which affect the efficiency of the lighting installation. The first exhibit, illustrating the law of inverse squares, consists of a movable lamp illuminating a screen, the distance of the lamp from the screen and the illumination of the latter being shown on scales graduated in foot-candles and inches. The law of reflection of light, and its importance in connection with the position of light sources with respect to the work, is demonstrated by another exhibit, while the effect of the reflection factor of the work on the amount of illumination required is also shown. Other exhibits show the value of shadow as an aid to the discrimination of detail and the disadvantage of shadows produced by unsuitable arrangement of light sources. Important exhibits are those which demonstrate the effect of illumination on the rate of perception, and the effect of direct glare from bright unscreened light sources near the line of vision. Not only are accidents caused by failure to provide sufficient illumination to permit the quick perception of obstacles or moving parts of machinery, and by the temporary impairment of vision brought about by glare, but serious loss of output also results from these conditions.

Two exhibits illustrate the importance of keeping lamps and fittings clean if loss of efficiency is to be avoided, and in a model room, forming part of Exhibit 22, the effect of dirty windows in reducing daylight illumination can be seen. Exhibit 22 also shows the effect of window area on the illumination of wide rooms, and particularly the importance of carrying the window heads as high as possible, since the illumination of the back of a deep room depends largely on light received from the top of the windows. The advantage of roof lighting in securing even illumination is also shown. The effect of the colour of the walls of a room upon the illumination secured from a given installation is shown in another exhibit, while the influence of the spectral composition of the light used on the discrimination of slight differences of colour is demonstrated by Exhibit 24. Two exhibits are devoted to showing the minimum illumination values recommended by the Home Office Departmental Committee on Lighting in Factories and Workshops for certain classes of work, samples of which are shown, and there are two exhibits showing a variety of adjustable fittings for local lighting, with illustrations of their use. In Exhibit 2 some portable photometers are shown, and a further exhibit consists of a collection of industrial fittings, with notes on their special features and uses.

The lighting exhibition is not final; there is room for additional exhibits, and suggestions for the improvement of those now shown will always be welcomed.

A Visit to the E.L.M.A. Lighting Service Bureau

A visit of members of the Illuminating Engineering Society to the E.L.M.A. Lighting Service Bureau took place on February 28th, when Mr. C. C. PATERSON (Vice-President) presided.

After the minutes of the last meeting had been taken as read the HON. SECRETARY announced the names of new applicants for membership, which were as follows:—

Claudius, Chas.	Assistant Electrical Engineer, Burma Railways, India.
Huaux, Chas.	Editor of *L'Eclairage*, Rue d'Assaut, Brussels.
Masterman, C.	Technical Officer, The Gas Light and Coke Company, The Pines, Oxshott, Surrey.
Needle, W. E.	Electrical Engineer, 8, Woodhall Court, Welwyn Garden City, Herts.

The names of applicants presented at the last meeting were also read again, and these gentlemen were formally declared members of the Society.*

The CHAIRMAN then called upon Mr. W. E. Bush, Manager of the E.L.M.A. Lighting Service Bureau, to present an account of its recent activities. Mr. Bush's address served to show how the work of the Bureau is extending, and how new developments are constantly taking place. He referred to the popular Illumination Design Courses, to the special investigations conducted by Messrs. W. J. Jones, H. Lingard, J. L. H. Cooper and others, and to the useful educational campaigns now being conducted in the provinces.

This was the first occasion on which the recently reorganized Demonstration Theatre had been publicly shown, and members were much interested in the numerous ingenious devices, which included a revolving electric house, experimental shop windows, displays of poster lighting and floodlighting, etc. One of the most effective exhibits was undoubtedly the series of small models of factories, shops, etc., equipped with miniature lamps and designed to illustrate the comparative effects of good and bad lighting.

The address was followed by an interesting discussion, at the conclusion of which a cordial vote of thanks to Mr. Bush and to the E.L.M.A. Lighting Service Bureau for their hospitality terminated the proceedings.

Illustrations of these devices will be included in the full account of Mr. Bush's address, which, with the subsequent discussion, will appear in our next number.

* See *The Illuminating Engineer*, February, 1927, p. 50.

The Automobile Headlight Problem

By L. B. W. JOLLEY M.A. (Cantab.), M.I.E.E.

Paper presented at the Meeting of the International Commission on Illumination at Bellagio, 1927

General.—The controversy on the automobile headlight problem is essentially based on objectionable glare from headlights and its effect on visibility; or, in other words, "ocular insensitivity" produced by a glaring light source and the consequent reduction in visibility.

The first point for consideration is for whom legislation or improvement is required, and the paradoxical nature of the question at once becomes apparent. The motorist will require as much light on the road as he can conveniently obtain from his generating system; and the oncoming vehicle or pedestrian desires that he has only enough to render him visible at a distance. Thus a balance must be drawn between what is a good minimum driving light and what constitutes a non-glaring source.

The first of these requirements, viz., what may be considered a good driving light, has been the subject of much discussion in America, and various experiments have been initiated there to ascertain the best shape of beam and its luminous intensity in various directions which will produce sufficient illumination of the road surface without undue glare. American practice, however, appears to have progressed along the lines of a limitation of wattage of the lamp in a possible attempt to limit the speed of night driving. In Great Britain the average speed of night driving along country roads is probably higher than in the United States: in any case, higher beam candle-powers are desired. Thus the minimum beam requirements for a good driving light should be ascertained by experiment on the road for each country.

The second part of the problem, viz., what constitutes a glaring source, is one of considerable complexity, as, having decided how much glare is permissible, the limits of illumination on the eye and the methods of attaining such limits, there are three variable factors which tend to vitiate all of the results obtained. These are the effects of

(1) The initial setting of the headlight,
(2) The loading of the car, and
(3) Hills, corners and unevenness of the road surface.

These three factors are quite fortuitous, and although the headlight may be rigidly fixed by the manufacturer (apart from legitimate dipping) the other two variables must, it is considered, be neglected. Certain devices have been suggested whereby the headlights swivel automatically, but all such would appear to be equally inadvisable. Thus, the best that can be expected is that the manufacturer should fix his headlight in such a way (to be determined by a specification) that it is correct once and for all, and cannot be further adjusted by the motorist.

The problem is thus reduced to a consideration of (1) the illumination on the eye which can be tolerated, and the angle at which the light ray enters the eye; (2) its attainment consistent with a good driving light. Item (1) must be the direct result of experiment in the laboratory and on the road, conducted possibly along the lines of Bordoni's research and its later developments. Item (2), which is the most intricate side of the whole problem, is epitomized in the genealogical tree, Fig. 1, and in effect also reacts back on that side of the problem dealing with the attainment of a good driving light, as it also must take into consideration improved street and highway lighting, and improved visibility by means of increased field brightness. At the same time better beam intensity regulation is required, which thus includes in the problem the electrical design of the generating unit.

The programme of research involved, before a satisfactory solution can be expected, is as follows:—

(1) To discover a good medium driving light at a maximum speed to be determined, and
(2) The maximum illumination on the eye of (*a*) the the pedestrian and (*b*) the drivers of oncoming vehicles, which may be considered innocuous under road-traffic conditions.
(3) The design of a headlight to meet with the requirements of (1) and (2).

As items (1) and (2) have not so far been decided with unanimous approval, and item (3) is dependent on them, it would appear at first sight as if no steps could be taken before the first two items had been finally determined; and it is probably this tendency which has delayed progress. But there is one important improvement which can be introduced with little delay, and which has actually been current practice in certain countries for some time. Reference is made to the elimination of all focussing devices and the introduction of an international standard of divergence and beam with suitable tolerances. The object of this paper is to develop this idea into one of practicability.

Definition of Standard Divergence.—By standard divergence is meant a beam as shown in Fig. 2, which

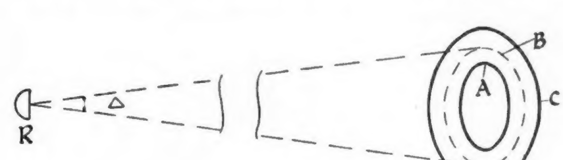


FIG. 2.

always tends to a divergence of △ degrees, and which fills a given target B with specified and allowed tolerance of A to C, when any lamp is placed in any reflector.

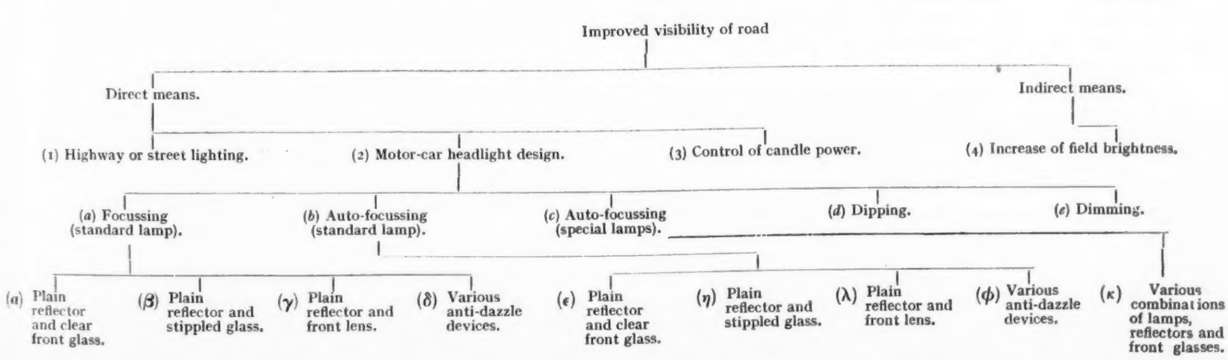


FIG. 1.

With such a standard divergence to work upon, it is possible for the designer to spread or manipulate the light as he pleases by means of additional optical elements in the headlight.

For the test of divergence the beam must be unshaded, i.e., there must only be clear glass interposed between the reflector and the target. If this is done the edges of the beam will be reasonably sharp and easily delineated.

Definition of Standard Beam.—By standard beam is meant a beam of a given polar distribution of luminous intensity. At this point there is a difficulty: the unshaded beam is made up of overlapping images of the filament, and of necessity is largely striated. For any photometric measurements it is essential that the images should be so muddled that the illumination on the target is reasonably graded. This can only be accomplished by some form of ground or stippled glass, which itself must have an arbitrarily specified diffusion. If such a standard front glass is interposed in the beam an illumination curve may be obtained as shown in Fig. 3, and it is usual with such beams to specify that the divergence

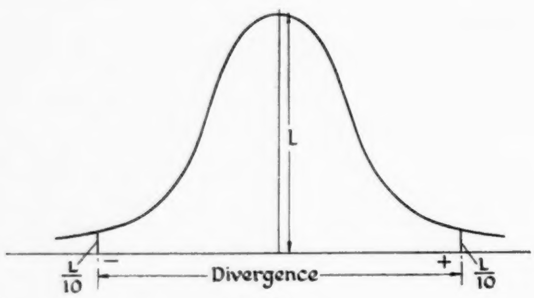


FIG. 3.

is the angle subtended by ordinates which are equal to one-tenth the maximum illumination, although this figure bears no definite relation to that obtained with the unshaded beam.

If the divergence is fixed, together with its tolerances, it is not safe to assume that a standardized beam will result; the variations, provided that a standard divergence is assumed, will be those consequent on deviations in reflector profile, voltage of supply, filament sagging, and the like, which may render the beam irregular in shape and luminous intensity. If desired, a standardized beam may be effected by the employment of a target as shown in Fig. 4, which suggests the imposition of tolerances in luminous intensity of the lamp as

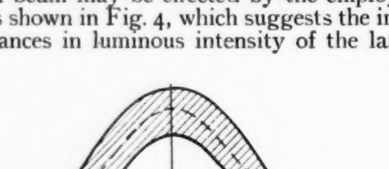


FIG. 4.

well as the supply voltage, a condition which would be difficult in application, but nevertheless highly desirable.

Importance of Standardized Divergence.—Having defined standardized divergence, it is worth noting the effects which may be encountered if little or no attempt is made at standardization.

It is well known that by tracing out the rays of the reflected light from the position of the filament in front and behind the focal point, a point of cross-over occurs where the beam is, as it were, inverted, this occurring at the point of minimum divergence.

This fact is illustrated in Figs. 5A, 5B and 5C, where the line PP passes through the focal point, and the aperture of the upper half of the reflector is interrupted in each case. Q represents the projection of the beam on to some suitable surface, at such a distance from the reflector that all major crossing of rays is completed. In the case of Fig. 5A the greater portion of the filament is behind the focus, and in Fig. 5B it is set for a position of minimum divergence, whilst in Fig. 5C it is in front of the focal point. The resulting beam is then found to

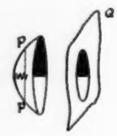


FIG. 5A.

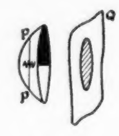


FIG. 5B.

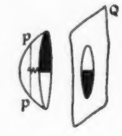


FIG. 5C.

consist of (*a*) a semi-circle with apex downwards, (*b*) a circular beam of one-half the average luminous intensity, and (*c*) a semi-circular beam with diameter downwards.

This fundamental fact indicates at once the vital effect of focussing on all kinds of anti-dazzle devices, and at the same time it illustrates the importance of the attainment of a standardized divergence, where by standardized divergence is meant a beam which behaves in a reasonably similar way if any lamp is placed in any reflector, without the aid of a focussing device. The alternative is the possibility of a complete inversion of the beam in the hands of a careless motorist, and a light distribution of the form which is just the reverse of what is wanted.

When the lack of interest and carelessness of the motoring public in the handling of optical devices is considered the importance of eliminating all adjustments, however trivial, is realized.

Obviously the first step towards the attainment of this standardized divergence must be to ensure that the major part of the filament is always on the one side or the other of the focal point, preferably in front of it when all tolerances of manufacture of both lamp and reflector are combined and included. This preference is shown as there is a greater tendency to a bright core to the beam when the filament centre is on that side of the focus which is away from the apex. Having achieved this end, the only remaining point is to fix a tolerance on beam divergence, and ensure that the combined manufacturing tolerances are such that the minimum divergence allowable is not exceeded. Thus, provided that the manufacturing tolerances, which are the responsibility of the lamp and reflector maker, can be reduced to a lower figure than those required for the beam divergence, then standardized divergence is secured.

It has long been felt by many that this is the fundamental requirement for all forms of headlight projection and that it is hopeless to attempt to attack the problem till it is accomplished. Immediately standardized divergence is obtained, the majority of the inventions which at present are in many cases worse than useless become a practicability, and some of considerable value.

This point has been emphasized since the fundamental proposition appears to have been avoided, for the reason apparently that, with the provision of focussing devices, there has been no call for anyone to attempt to reduce the tolerance on manufacture, and this laxity has led in some cases to legislation of an impracticable character.

If it can be assumed, therefore, that a beam is attainable which has a definite and agreed tolerance on divergence, and which, moreover, is always obtained by the filament situated on the same side of the focus, the actual position to be agreed, then such simple devices as front lenses and the like can be used with the assurance that no beam inversion will result when they are employed.

OPTICAL PROJECTION.

Point Source.—The importance of divergence has been discussed, but it is advisable to consider in some detail the process by which standardization is made possible, due in a great measure to the results given below, which are fundamental to standardization and which are the outcome of a lengthy mathematical analysis of the subject by J. W. Ryde.

Consider the case of a point source and assume that it is displaced along the axis of the parabolic profile. Then it can be shown that as the point moves from the apex through the focus and beyond, the divergence decreases to zero and follows the curve AOB in Fig 6.

If the portion OB of the curve is inverted into the (– –) quadrant, the curve will be found to be continuous, suit-

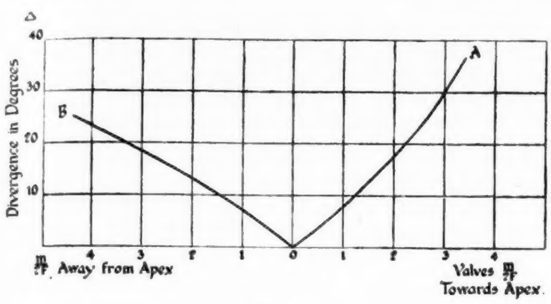


Fig. 6.

able changes in sign taking care of the relative ordinates and abscissæ. The abscissæ of the curve are taken to be values of $\frac{m}{2F}$, where m is the distance of the source from the focus and F is the focal length of the reflector. The reason for this procedure will be apparent later; but it will be seen that the curve is quite general in character, and can be applied to any one reflector of a given focal length by multiplying the abscissæ by twice its focal length.

This curve AOB is the basic curve for all parabolic reflectors, and from it much useful information is to be gained.

Line Source.—Turning to Fig. 7, where the fundamental curve is again AOB, and assuming that the source

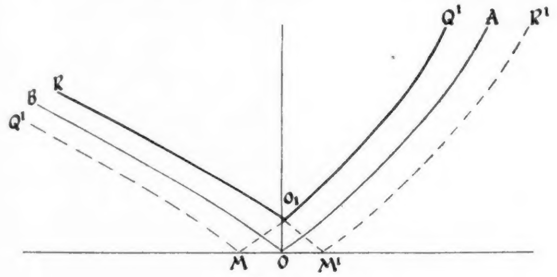


Fig. 7.

of light consists of a line of length MM^1, the divergence will then follow the curve RO^1Q^1, which is determined by two curves QMQ^1 and RM^1R^1, each similar to the original curve AOB but displaced parallel to it a distance equal to one-half the filament length in either direction.

For the calculation of the minimum divergence for a line source of light, or the height of o^1 above the axis, it is apparent that both the filament length and the focal length are involved, and it can be shown that the relation between the quantities is

$$\Delta^\circ = \frac{36\cdot85\ L}{F}\ \left\{\frac{L}{F} < 1\cdot0\right\} \quad . \ . \ . \ . \ . \ . \quad (1)$$

This equation, which is simple in form, is in reality a simplification of a complicated function, the simplification being possible only on account of the limits assigned to its range of operation.

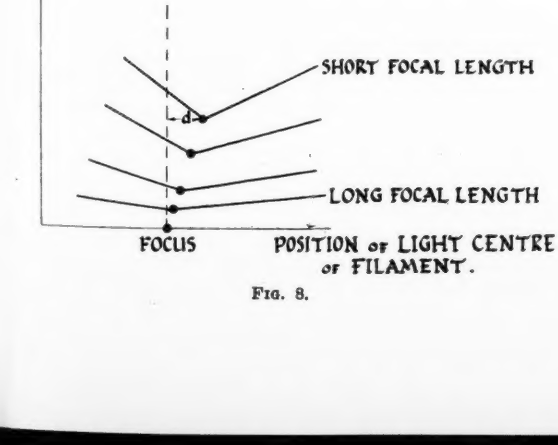


Fig. 8.

If it is required to ascertain the effect of varying the focal length of the reflector it is necessary to multiply all the abscissæ of Fig. 6 by F^1 in the place of F where F^1 is the new focal length. If F^1 is greater than F this will have the effect of increasing the angle AOB, and if the displacement operation of Fig. 7 is then performed it will be found that a family of curves can be drawn for various focal lengths as shown in Fig. 8.

The distance d in the figure, which represents a slight deviation of the filament centre from the focus, can be calculated from the equation:

$$d = 0\cdot0895\frac{L^2}{F} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (2)$$

the error being less than 2 per cent. of the ratio $\frac{d}{L}$, but in any case its absolute value is small.

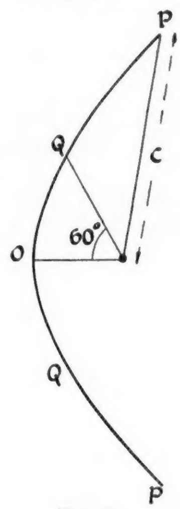


Fig. 9.

As the minimum divergence is decreased by an increase in the focal length, so the luminous intensity in the beam is increased; on the other hand, the light collection for the same reflector diameter is decreased, and therefore the luminous intensity is decreased. There is thus an optimum point where the focal length will result in a maximum luminous intensity, the filament always being at the point of minimum divergence. If in Fig. 9 the dimension C is taken to be constant, the focal length for this condition is found to be

$$F = \frac{2}{3}C \quad . \ . \ . \ . \ . \quad (3)$$

which is accurate to within 1 per cent. of (C–F).

The final point in connection with a linear source is that of the part of the reflector which contributes the rays of maximum divergence.

In Fig. 10, if the angles θ_1 and θ_2 lie somewhere between 55° to 65°, the exact value depending on the conditions, it will be found that the maximum divergent rays I and II emanate from an annulus Q of the reflector, whilst those from R, viz., III, cross I and II at some point which may be a considerable distance from the reflector; the final crossing of all these rays only occurring just before an infinite distance is reached. If

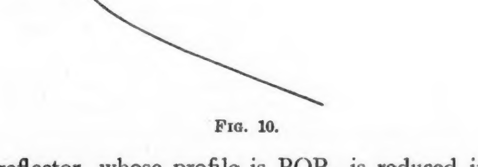


Fig. 10.

the reflector, whose profile is PQR, is reduced in size (but not in shape), the maximum divergence will not be affected until the portion Q is reached, after which any attempt to render the reflector more shallow will reduce the maximum divergence.

It is also to be noted that the portion of the source nearer to the apex than the focus contributes rays which never cross the axis; whereas rays from that part of it at L away from the apex in some cases cross the axis, then become parallel to it and finally diverge from it, depending on the portion of the reflector considered. This point is of importance in considering the tolerance of

filament length permissible and its effect on the production of a black spot.

Disc Source.—In the case of a disc source of light whose centre coincides with the focus, and whose axis is coincident with that of the parabolic profile, the fundamental curve is that of SOS' in Fig. 11. As the disc,

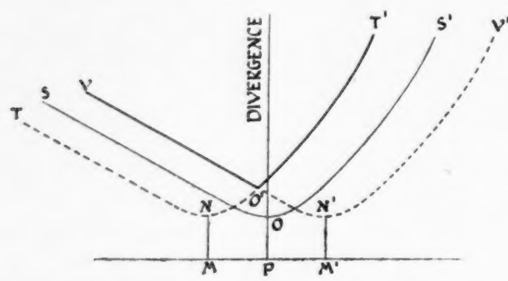


Fig. 11.

though infinitely thin, has linear dimensions, the minimum divergence will never be zero, but will have a value represented by the ordinate OP.

The divergence due to a cylinder is obtained in the same way as for a linear source. If the cylinder has a length equal to MM', the curve SOS' is then displaced as distance equal to one-half the cylinder length on either side of the point O, and the divergence is given by the curve VO'T'. When the cylinder radius is small this becomes coincident with the curve RO'Q' of Fig. 7.

In the case of a disc of diameter L the value of the minimum divergence is given approximately by the relation:

$$\Delta^\circ = \frac{57 \cdot 3\ L}{F} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Black Spot Filament Length Permissible.—It will be apparent that so long as the linear source embraces the focus there will be a bright core to the beam consisting of parallel rays as well as a similar core of a variable character due to crossing rays, but as soon as the source lies either wholly towards the apex or away from it a dark spot will appear.

Filament Towards Apex.—In this case no rays cross the axis and the dark spot (which is not wholly black, as it is partially illuminated by rays emanating from the apex of the reflector) becomes bigger as the source is moved towards the apex. The black spot, however, is apparent on a target as it is moved from the reflector to infinity.

Filament Away from Apex.—The rays cross the axis of the reflector and this point of crossing will be apparent as a bright core, but as the target is moved away from the reflector the black spot will appear.

Thus it can be assumed that there will always be a preference for the filament to be away from the apex as a brighter core results, provided that precautions are taken to intercept the beam on its target at a point between certain defined limits.

Without further discussion it can be granted that the less shallow the reflector the bigger will be the tolerance on the position of the target without a black spot occurring, and the brighter will be the core.

Consider the important factors which can be deduced from these purely theoretical considerations in so far as the problem of standardization is affected:

(1) The slope of the curves connecting divergence and filament position is approximately constant and independent of the filament length; it depends only on the focal length of the parabola.

(2) The minimum divergence or starting point of the lower tolerance in beam divergence, viz., A in Fig. 2, depends both on the filament length and inversely on the focal length.

(3) If the reflector is too shallow, i.e., embracing less than about 120° of the source, Equation (1) does not apply and the divergence at the normal minimum position will be decreased.

(4) A linear source should be so positioned that its centre lies on that side of the focus which is away from the apex.

(5) In the case of axial filaments the tolerance on filament length combined with that of light centre length must be such that it always embraces the focus. This in general will be accomplished automatically, and must be modified for other shaped filaments.

(6) A decided preference is shown for deep reflectors of a long focal length, but as this design entails an overall maximum diameter of headlight of considerable dimensions, a compromise must be effected.

(7) With a given value of C (Fig. 8) there is a focal length which will result in maximum beam intensity (Equation 3) when the filament is at the position of minimum divergence.

Design of Optical System.—The procedure by which the optical system must be designed is therefore as follows:—

A standard divergence has to be assigned, together with its tolerances, i.e., B + (C - B) - (B - A), as indicated in Fig. 2.

The exact magnitude of the complete tolerance (C - A) which is expressed in degrees, must then be converted into linear measurement of light centre length tolerance by means of a curve similar to one such as is shown in Fig. 8, and it will be apparent that this conversion will involve a specification of the focal length of the parabolic profile. This having been ascertained by practical consideration of such effects as mentioned in Item 6 above, Equation (1), and the magnitude of the lower limit of divergence A, will enable the actual length of the filament to be calculated. The tolerance on light centre length of the filament will be divided between the lamp and the reflector makers, the latter only being concerned in so far as the position of the lampholder relatively to the focal point is concerned and its tolerances in manufacture.

Thus the correct sequence of standardization is as follows:—

(*a*) Determination of mean divergence.

(*b*) Determination of tolerances in the same.

(*c*) The selection of a standard focal length of reflector, due consideration being paid to the overall diameter and amount of light collection, etc. (See Item 6.)

These three points being fixed, other matters such as filament length, tolerances on manufacture of lamp reflector, etc., automatically follow.

Finally, consideration must be paid to the shallowness of the reflector, in so far as it affects the divergence, or, if a V-filament is employed, the circularity of the beam, a factor which is discussed later.

It may be objected, and with truth, that the method outlined above may be unfair to manufacturers, and that the tolerances in manufacture should be the starting-point. It is, of course, assumed that if the suggested procedure is followed the standard fixed should be by agreement. On the other hand, it is possible to invert the process and commence with the manufacturing tolerances and finally arrive at the tolerances in divergence.

Lamp Design.

There are two types of filament employed in Great Britain, viz., the axial, which is the more popular, and the V-spiral, and the relative merits of the two will now be considered. Other special lamps are not discussed, as they do not contribute to the problem of standardization.

Axial Spiral.—If the spiral is arranged so that it coincides with the reflector axis then it is obvious that the beam will be symmetrical and circular in shape.

Practical divergence curves have been obtained with axial spirals of various filament lengths, and some of them are reproduced in Figs. 12, 13, 14 and 15.

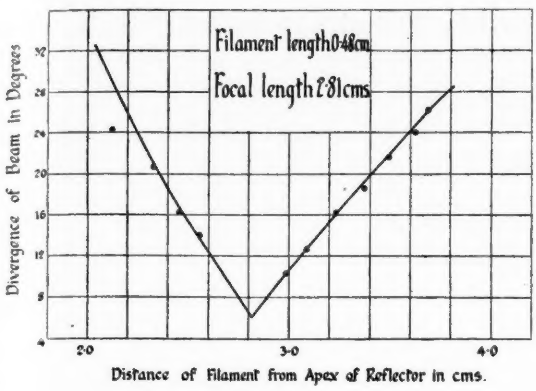


FIG. 12.

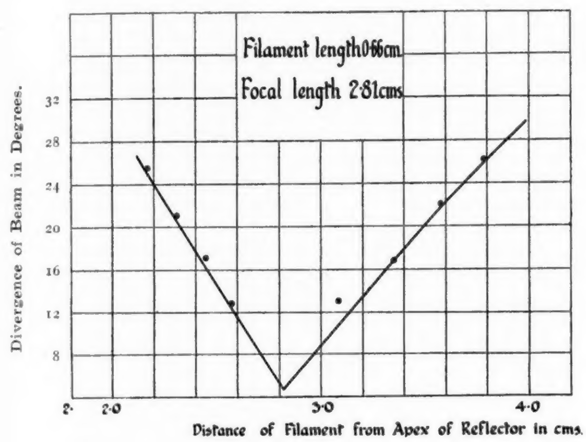


FIG. 13.

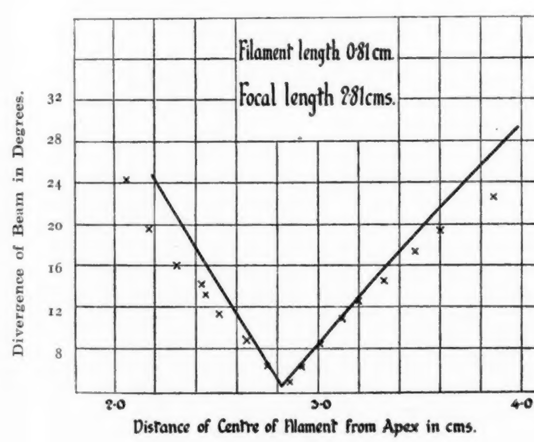


FIG. 14.

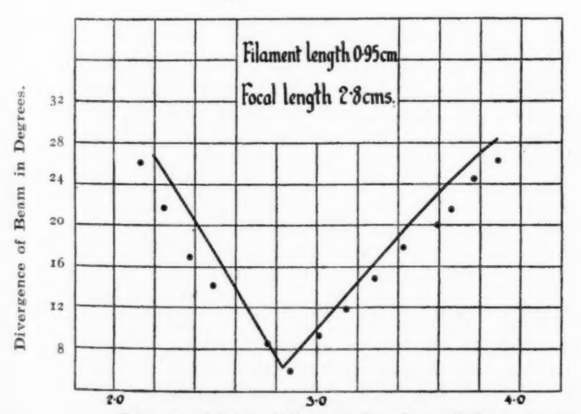


FIG. 15.

If the minimum divergences are plotted against the filament lengths for both the V-curves in the above Figs. 12 to 15, and according to Equation (1), Fig. 16 is obtained, the difference between the measured and the calculated being due to the slight rounding off of the V-curves, as the filament is cylindrical and not truly linear.

On these diagrams the isolated points represent the measured, and the continuous lines the calculated, values. As the scale of abscissæ is large, it will be noted that the agreement between theory and practice is exceedingly good, and at the same time the independence of divergence tolerances on filament length, or the constancy of the angle enclosed by the V-curves, is clearly demonstrated.

V-Spiral.—It is probable that the effect on the beam of such a variation in filament shape as an alteration from an axial spiral to a V-spiral or the limiting case of a single spiral placed at right angles to the reflector axis has hitherto not been generally understood; and while it is not possible to enter into the underlying analytical theory the results of such investigations should be recorded.

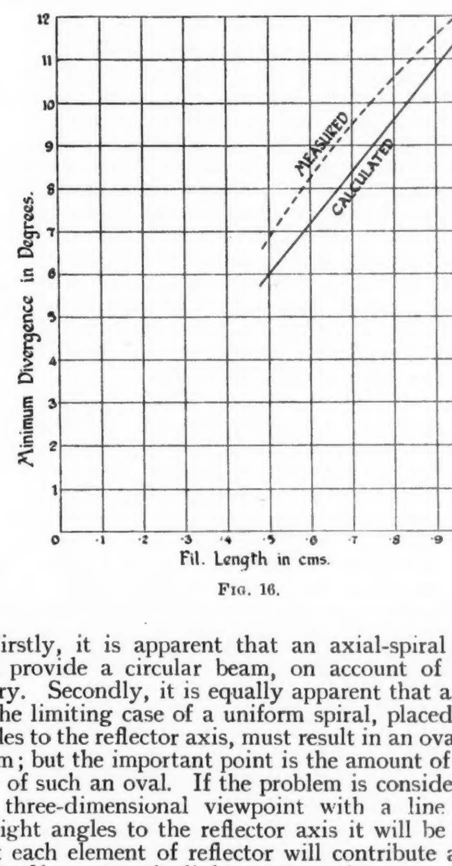


FIG. 16.

Firstly, it is apparent that an axial-spiral filament will provide a circular beam, on account of its symmetry. Secondly, it is equally apparent that a V-spiral or the limiting case of a uniform spiral, placed at right angles to the reflector axis, must result in an oval-shaped beam; but the important point is the amount of eccentricity of such an oval. If the problem is considered from the three-dimensional viewpoint with a line filament at right angles to the reflector axis it will be apparent that each element of reflector will contribute an image of the filament to the light patch on the screen, and that each image will be that of the filament itself.

The element of reflector at the apex O, Fig. 9, will produce an exact image of the filament, and as positions of the reflector are considered from O to Q, so will the beam become less and less oval. Thus, in the limiting case of this particular filament shape the ellipticity of the beam is dependent as much on the shallowness of the reflector as on the shape of the filament itself. Further, as all inaccuracies of mirror surface tend to a larger divergence, on that account also will the beam tend to lose its ellipticity and become circular.

This effect can be readily demonstrated by inserting a V-filament in a deep reflector (i.e., one of short focal length and large pick-up) and gradually blacking annular elements of the reflector surface. Until approximately the 60°-point there is little or no difference in the length of the major axis of the oval, but the beam contracts in height, the minor axis becoming less in length at the first contraction in the aperture. The V-filament is an intermediate case between that of the

axial filament placed on the reflector axis and where it is at right angles to it, and will therefore tend to a more circular beam than the latter.

This point is of interest in deciding the shape of the filament, and it is apparent that the ellipticity of the beam due to a V-filament can only be justly claimed when shallow reflectors are employed. In a particular case with a reflector embracing approximately the angle POP in Fig. 9, the eccentricity was only 1.06, and the beam was very nearly circular.

As a preference has been shown in this paper for deep reflectors, it would appear that whereas V-filaments will, under such a condition, tend to lose their qualification for producing an elliptical beam, on that account they will not adversely affect standardization by providing an asymmetrical beam. But if a V-filament is employed in conjunction with a shallow reflector to give an oval beam, then there is the added complication of arranging that the lampholder is always so fixed in the reflector that the major axis of the beam is horizontal.

Anti-Dazzle Devices.—The number of devices which have been advocated for the prevention of glare illustrates the attention which has been paid to the subject; yet few of them are fundamentally sound or probe to the root of the question.

All anti-dazzle devices depend for their action on the accurate alignment of the projector, and although all headlights should be accurately adjusted, especially is this the case here. It is interesting, therefore, to note that in a survey of 200 cars in America, 81 per cent. were found to be tilted downwards, 14 per cent. were tilted upwards, and only 5 per cent. had their beams horizontal. It may be advanced, and with truth, that inaccuracies of loading, variations in the road surface level, and so forth, render alignment inaccurate, but that is no reason why it should exist only in name, and a plea is put forward for the greatest possible accuracy in fixing headlights rigidly, so that they cannot be tampered with by the public, and to consider other variables as being largely fortuitous.

Conclusion.—The concrete and definite recommendation embodied in this paper for the consideration and preparation of international standards of divergence and beam is not put forward as by any means a complete solution to the problem, although there are those who feel that such desirable conditions, combined with a rigid mounting of the headlight on a car pointing in a definite direction, might, without any other special devices, so reduce the present annoyance that no other legislative action would be required. Be that as it may, the present proposal is for the building of a sure foundation of international repute, agreed by users and manufacturers alike.

The other problems foreshadowed earlier in this paper may or may not be then acute; but if it is necessary to consider them later it will be with the assurance that the vagaries of the source of light are controlled, even though the source itself be misdirected.

Motor Vehicle Lighting

The report of the Committee on Motor Vehicle Lighting, which appears in the January issue of the Transactions of the Illuminating Engineering Society (U.S.A.), embodies the results of a survey of rules governing the approval of headlights in the United States. The original set of rules was prepared by the Committee in 1917, and was revised at intervals until 1922. On these rules were based the "Specifications for Laboratory Tests" of electric headlights approved by the American Engineering Standards Committee in 1922. The specifications have stood without revision for some years, but the recent development of the "dual beam" system has made some modification desirable. The specifications now presented deal with laboratory tests of headlights, rear lights and signal lamps. Other information is presented in appendices. Mr. H. H. Magdsick compares European regulations with those in the United States, and Mr. A. W. Devine reports on headlight law enforcement in Massachusetts.

Further Tributes to the late Mr. L. Gaster

At the meeting of the National Illumination Committee of Great Britain, on February 3rd, the following resolution was passed unanimously:—

"That this meeting of the National Illumination Committee of Great Britain desires to recognize the eminent services rendered to this Committee and the International Committee by the late Mr. Gaster, and deplores the great loss to the Committee—and illuminating engineering generally—has sustained by his death."

The following letter from M. A. FILLIOL, President of the Swiss National Illumination Committee, was also presented:—

"I greatly regret to hear that Mr. Leon Gaster, one of the founders of the British Illuminating Engineering Society and a member of your Committee, died last month. The death of Mr. Gaster, the active and world-wide-known promoter of illuminating engineering, is indeed a great loss not only for great Britain but for the International Illumination Commission in general.

"The members of the Swiss National Illumination Committee remember Mr. Gaster's active collaboration at the session in Geneva in 1924 and in Bellagio in 1927. They are particularly grateful for the sympathy he showed for our country, a sympathy that dated from the time he studied at the Federal Technical University in Zurich.

"May I ask you, dear sir, to express the sincere regrets of the Swiss National Committee to its British sister organization for this great loss, and be assured that the Swiss Committee will remember Mr. Gaster as one of the pioneers in electrical illumination and a straightforward and friendly colleague."

The following correspondence has also taken place between the Presidents of the Illuminating Engineering Societies in the United States and in this country:—

Dear Sir,

News has just been received in this country of the loss which the Illuminating Engineering Society of Great Britain has suffered through the death of its Honorary Secretary, Mr. Leon Gaster. On behalf of the Illuminating Engineering Society in America, I wish to extend to you our condolences.

Through all the ten years of its existence we have followed with sympathetic interest the progress of your Society and have rejoiced in its ever-increasing strength. We have noted what a considerable part Mr. Gaster had in this connection and feel that the loss of his energetic and enthusiastic efforts cannot fail to be severely felt. Knowing, however, something of the character of the membership of your Society, we have no question but that whatever reaction Mr. Gaster's loss may have upon you will be only temporary.

With sympathy for your loss and best wishes for your future prosperity, I beg to remain,

Faithfully yours,

NORMAN MACBETH, President

(Illuminating Engineering Society, U.S.A.).

Dear Sir,

I write to express my grateful appreciation of the message of condolence contained in your letter of the 4th inst. on the death of our Hon. Secretary, Mr. Leon Gaster. His loss, as you clearly realize, must be severely felt for a long time, but I am glad to say that the members of the Council of our Society are taking active steps to ensure its successful continuance, and in so doing cannot fail to be influenced by the knowledge that they have the sympathy and co-operation of the Illuminating Engineering Society of America.

I shall take steps, of course, to communicate the contents of your letter to the Council at their next meeting, but in the meantime would ask you to accept my personal thanks for your kind consideration.

I am, yours very faithfully,

D. R. WILSON, President

(Illuminating Engineering Society of Gt. Britain).

Traffic Signs and Signals

A PAPER on the above subject was read by Mr. W. J. Jones at the meeting of the Association of Public Lighting Engineers, held at the E.L.M.A. Lighting Service Bureau, on February 21st.

In his introductory remarks Mr. Jones recalled that the authority for setting up sign or direction posts is derived from Section 24 of the Highway Act, 1835, which places the matter in the control of highway authorities. Great credit is, however, due to the active pioneering work of the Automobile Association in this field.

Just as street lighting is now held to be no longer a parochial matter, so the general question of traffic signs needs consideration on a wider basis. In a circular letter issued by the Ministry of Transport in 1921 attention was drawn to the variety of signs and directions, both official and unofficial, and a joint committee was appointed to enquire into the whole matter. It was then strongly recommended that highway authorities should introduce only standard forms of direction posts and warning signs. Since 1921 road signs and signals have multiplied, and much remains to be done in regard to standardization.

In some areas no attempt is made to light up traffic signs, in others the traffic sign is incorporated as part of the street-lighting equipment. This procedure is rarely quite satisfactory. The brightness of a sign which is adequate for rural areas may be quite unsuitable in a city, where the sign has to compete with public lamps and the general illumination in the street. Many signs, again, are spoiled by the fact that the light source is unscreened and visible, causing glare. This point is of special importance on country roads, where the eye is in a very sensitive condition owing to the prevailing darkness.

In the next section of his paper Mr. Jones drew attention to the variety of signs in use, e.g., direction signs, danger signs, safety zones or islands, crossing points for pedestrians, etc. The most important quality of a sign by which its effectiveness is judged is *visibility*, both by day and by night. The message must be understood at a distance sufficient to ensure complete control of a motor-car. It is often possible to install warning signs at, say, 75 or 100 yards away from the object of danger. But in many cases the warning device is placed on the actual site of the dangerous object; e.g., at cross-roads, cul-de-sacs, level crossings, etc. Such signs should possess correspondingly greater visibility.

In order to illustrate the visibility of existing devices Mr. Jones also presented data showing the distance at which certain forms of signs could be distinguished. The greatest "legible viewing distance" by day was for the triangle-type warning sign and the flambeau school sign. Other devices could themselves be distinguished at distances of 65 to 90 yards, but the lettering could only be made out at a distance of 20 yards.

The "legible viewing distance" by night naturally depends on the nature of the device and the manner in which it is illuminated. From the data presented bearing on this question it appeared that the distance lamps screened by ruby glass varied from 150 to nearly 500 yards, whereas the "legibility" was in general much less. Signs composed of lettering on a coloured ground could naturally only be distinguished at lesser distances. It is instructive to note that one form of temporary danger sign, a 12-watt electric lamp placed behind a ruby pane, was evidently liable to be confused with the rear lights of motor vehicles.

Attention is drawn to the following points deduced from this investigation:—

(1) The distance at which signs are legible at night is generally much greater than by day, whilst experience shows the "noticeability" is also greater at night.

(2) The use of a dioptric lens adds very greatly to visibility, owing to the higher beam candle-power. It would seem that "noticeability" increases with visibility at a rate much greater than the linear law.

(2) Red danger signs at a low mounting height are liable to be confused with rear lamps of cars.

(4) It is necessary to allow for the presence of competing light sources.

(5) In the case of an obstruction the nature of this obstruction should be rendered discernible.

Amongst further considerations it is noted that:—

(*a*) Traffic signs should be designed to give the maximum possible notice of their existence, i.e., they should be seen as long as possible before the actual danger point is reached. The distance at which a sign should be visible is apparently a function of the square of the speed of travelling.

(*b*) The use of standard signs throughout the country would greatly facilitate identification of them by drivers of cars.

(*c*) The brightness of signs in city areas should be greater than that of similar signs in urban areas.

(*d*) In order to avoid possible confusion with other signs traffic signs should take a form similar to that of the daylight signals on railways, and should also incorporate the standard device specified by the Ministry of Transport. It might also be advisable for the sign to be flashed periodically; this step would also help to prevent red danger signs being confused with tail-lights, etc. In order to illustrate the distinctiveness of flashing signs the author quotes the results of some American tests. These showed that with non-illuminated signals 60 per cent. of people did not observe the signals; with steady-burning signals 47 per cent. did not observe them, whilst with every flashing type only 9 per cent. did not observe them.

Flashing beacons at cross-roads in this country have proved very satisfactory, but the question of obtaining permission to employ flashing signs in certain districts needs consideration, as by-laws vary considerably.

There are now available many excellent examples of lighted direction signs. Observation of the recommendations contained in the Ministry of Transport's circular letter of 1921 would do much to bring about standardization. The red triangular sign is specified as the danger signal, and symbols for indicating schools, level crossings, cross-roads, etc., are also given. These should be installed 75 to 100 yards from the object of danger or the commencement of the danger zone, and an unrestricted view of the danger signal should be available. The Ministry also recommends that lighted signs should be 1½ times the standard size, probably in order to ensure complete daylight visibility. On all such questions the Ministry makes merely strong recommendations, but in London, through the Traffic Advisory Committee, there is more complete control.

These recommendations, however, do not discriminate between rural and city areas, nor do they specify minimum legibility or viewing distance of the warning at night-time, nor the brightness to which the signals shall be lighted. Some suggestion as to the minimum illumination would help to improve the general effectiveness of signs. There also seems a need for an investigation into the type of opal glassware employed for traffic signs, some varieties being unduly dense. There are also variations in the colour of the red signals employed. There is no standard prescribed for traffic notices, but here again, as they are used mainly in city areas, the lighting must be of a high standard so that the notice will stand out boldly. Disfiguring signs should be avoided, and there seems an opportunity for more artistic feeling than is commonly shown.

Experiments with the object of lighting up the traffic officer on point duty are now being made, but due attention should be paid to the contrast with surroundings—in some cases efforts to illuminate the officer may render him less conspicuous. In this connection Mr. Jones described the arrangements adopted at Croydon, Hornsey and other localities.

Reference was then made to traffic-control signals. The author has been impressed by the smooth working of the arrangements in New York, Cleveland, Boston, and other American cities. In America control is

effected mainly on three distinct systems: (1) manual control of signals by officers on duty in the vicinity; (2) the synchronized system; and (3) the progressive system. In such instances signals are usually of the red "stop" and green "go" types, and utilize dioptric lenses similar to those used for daylight signals on railways. The manual-control method is similar to that used in Piccadilly, but is giving place to other methods. Under the synchronized system all signals along the section of the road display the same colour simultaneously, thus enabling north and south traffic to move whilst east and west bound traffic stops, and vice versa. In the progressive system the signals are staggered alternately red or green for every block of the street, or in groups of two or three blocks. When properly spaced and timed, vehicles starting at the beginning of the street on the green light and travelling at a predetermined speed can travel to the end of the street without stopping. This progressive system seems quite satisfactory for the less congested areas, but the synchronized system meets the need of the more congested areas. The introduction of such systems in the United States has been aided by the general rectangular lay-out of the streets, but nevertheless the author believes they could be applied with advantage in many places in this country. Such traffic-control methods have the great advantage of being equally available during day and night.

With the exception of signposts erected by the A.A. and the R.A.C., direction posts and warning signs are installed at the expense of local authorities, but the Ministry of Transport is prepared to assist both in regard to capital charges and maintenance. The question of hours of lighting up and extinguishing the various types of traffic signs might well be considered with those for general street lighting, except in cases where all-night lighting is desirable. Many signs are at present operated by time-switches, which automatically light up and extinguish at predetermined times.

In the author's opinion, the whole question of installation and general maintenance of traffic signs and signals should come under purview of the public lighting engineer working in conjunction with the appropriate traffic authorities or committees.

In conclusion, the author presented the following proposal: "A Committee be set up forthwith, representative of all interests, to consider the question of traffic signs and signals, with a view to making recommendations for their improvement as regards effectiveness, and to deal further with the question of standardization."

In the subsequent discussion the Chief Constable of Huddersfield, Mr. S. B. Langlands (Glasgow), Mr. J. Christie (Electrical Engineer, Brighton), Mr. P. Good (British Engineering Standards Association), and representatives of the Automobile Association, the Ministry of Transport, and other bodies took part.

The Chief Constable of Huddersfield, referring to the growing volume of traffic in the provinces and the desire for greater speeds, said the question of the illumination of street signs was one of direct interest to the police. A committee on the lines suggested should prove useful, but it should have the support of some Government Department, such as the Ministry of Transport. Mr. S. B. Langlands emphasized the desirability of co-operation between city engineers and the police, and Mr. H. E. Aldington (Ministry of Transport) described some of the devices in use, emphasizing the importance of analysis of traffic in deciding the position and nature of signs.

Traffic usually varied greatly in different areas, and he doubted whether a synchronized system of control would prove practicable in this country.

Some discussion took place regarding the constitution and functions of the Committee proposed by Mr. Jones, and ultimately the following resolution was adopted:—

"That a conference be called by the British Engineering Standards Association of all interested parties for the purpose of setting up a committee for the consideration of road signs and signals."

Theatre Lighting

An interesting paper on the above subject was read by Mr. Henry D. Wilkinson before the Royal Society of Arts, on February 8th. Attention was drawn to several notable developments. For auditorium lighting a dazzling display of innumerable points of light has given place to softer effects from fewer and well-screened sources. On the stage the overhead lights (battens) and footlights (floats) of the open type with a simple enamelled reflecting surface have given place to fittings of the magazine pattern with a separate compartment and reflector for each lamp. The use of gelatine coloured films has eliminated the ceaseless trouble caused by efforts to coat lamp bulbs with colouring materials. The high candle-power of modern gasfilled lamps has also almost resulted in the disuse of arc lamps for floods, projectors and spots, but arcs are still retained where actinic value is desirable, or for spotting from the front of the house when the throw exceeds 60 feet.

All such improvements are intimately bound up with developments in the control and regulation of current supplying the lights. The rise in the pressures commonly used in theatres (in Glasgow the pressure between the outer wires of the three-wire system attains 500 volts) has rendered good insulation and careful protection essential. All resistances liable to become heated are now housed in fireproof and well-ventilated chambers. Space is very desirable. Even to-day the clearances in many equipments are so limited that there is liability to shock or accidental connection. A good method is the construction of a control platform nine or ten feet above stage level. It is an advantage when the operator can see the actual lighting effects he produces. The position of the switchgear and controls at Drury Lane Theatre is at stage level adjoining the prompt, so that no signalling cues are required. In the latest installation fuses are grouped in accessible and usually fireproof positions, instead of being scattered all over the house in inconvenient places in order to save wiring.

In London safety regulations are imposed by the County Council, and plans of new work have to be submitted to them. Amongst other regulations it is prescribed that the lighting of the auditorium, corridors, staircases, passages, exits, etc., and all parts of the house open to the public, shall be from two independent sources of supply. The stage lighting is supplied from a third source; and here again, in the interests of reliability, a duplicate system of supply is desirable.

Producers set great value on that somewhat elusive but attractive feature known as "tone." This depends largely on the variety of reflectors employed, e.g., silvered glass, stainless steel or aluminium for the float, and either of the latter two for the battens. Except in spectacular revues, a comprehensive glare of white light over the whole stage is not desired so much as gradation of shades. Compositions and changes in the colours from battens and float will go a long way, but artistry is obtained chiefly by the skilful arrangements of whites and colours from wing floods. The author suggests an illumination from the front at the centre-point of the stage and four feet above floor level of not less than 30 foot-candles, with white lights only. A large stage may require currents of 100 amps. or more for special effects. For this purpose it is impracticable to use plugs, and the circuits are separately wired to ironclad boxes, provided with substantial connections. Several forms of floodlighting were illustrated, one a wide-angled type fitted with 1,000 or 1,500-watt lamp and a reflector of polished aluminium; the other a new type of projector lantern chiefly used for spot lighting. The author also described modern forms of liquid and metallic dimmers, pointing out the great advantage in regard to flexibility possessed by the former. Gradual transitions in effects are very necessary.

In the next section of the paper Mr. Wilkinson discussed methods of stage wiring in some detail. Reference was made to special devices for the production of moving clouds and other atmospheric effects, and to the Schwabe horizon colour floods and the Schwabe-Haseit cyclorama—the latter a device specially suited to classical plays and opera.

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)

Methods of Calculating General Illumination Intensities for Interiors

By IMRIE SMITH, B.Sc.

(E.L.M.A. Lighting Service Bureau.)

FOR years the main problem of the electrical engineer lay in endeavouring to improve the power of his light sources, and it is only in recent years that he has been able to generate light in sufficient quantities to permit him paying more attention to the design of actual installations. The early forms of illuminants were too small and inconsistent in their behaviour to lend themselves to any degree of proper light control. Later, as the output and consistency of the light sources grew various types of reflectors were designed for control purposes, it not only became possible, but necessary, to develop some method of predetermining the illumination obtainable from a complete installation. As will be seen on the following pages, the "point to point" and the "watts per square foot" methods were the natural outcome of this need. With, however, the increasing use and importance of artificial illumination, and the growing appreciation of the necessity of employing specific illumination intensities, it has been necessary to develop a more complete system of calculation, such as the "lumen method."

In quest of information it was natural that the engineer should turn to physicists, as they had been studying light from a scientific point of view for a considerable period. From the mass of academic data, three things stood out as being of use; these were:—

(*a*) The polar curve of light distribution.

(*b*) The law of inverse squares.

(*c*) The cosine law.

The polar curve of the light distribution was an essential piece of data, as it indicated how the candle-power varied in all directions, and so formed a basis on which subsequent calculations could be made.

The law of inverse squares stated that the illumination on a plane perpendicular to the light ray varied inversely with the square of the distance from the light source. By means of information supplied by the polar curve, and with the aid of this law it becomes possible to determine the illumination at a point any given distance from the light source, the plane illuminated being taken as perpendicular to the light ray.

Finally, with the addition of the cosine law, which states that the illumination on a plane *not* perpendicular to the incident beam varies with the cosine of the angle subtended between the light ray and the normal to the plane, a means is provided of calculating the illumination on any plane at any particular position.

In the above manner the "point to point" method of calculating illumination was evolved.

When the illumination is produced by more than one light source, the method naturally has to be applied to each lamp in turn in order to effect a summation. Consider the illumination at the point P in Fig. 1, showing the plan of a room with four light sources.

Illumination at P

$$= \frac{\text{CpA}}{\text{AP}^2} \times \text{Cos } a + \frac{\text{CpB}}{\text{BP}^2} \times \text{Cos } b + \frac{\text{CpC}}{\text{CP}^2} \times \text{Cos } c + \frac{\text{CpD}}{\text{DP}^2} \times \text{Cos } d$$

Where AP, BP, etc., are the true distances between P and the centres of the respective light sources *a, b, c, d*, the angles that the above slant lines make with the horizontal, and CpA, CpB, etc., are the candle-powers given by the light sources along their respective slant line. Any modification of the mounting height changes the value of all three quantities.

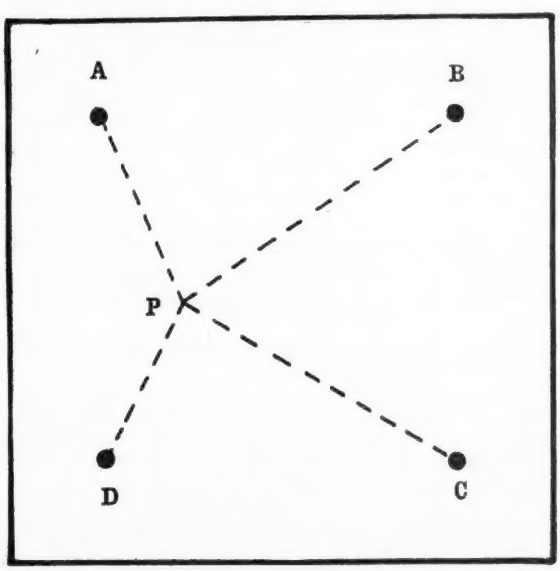


FIG. 1.—A Plan of a Room containing four light sources, A, B, C and D.

Although tables of constants have been prepared in order to minimize calculations, the process still entails obtaining two constants from a table, taking a candle-power reading from a polar curve, and a multiplication for *each lamp*, this having to be done for every point considered. It should be remembered that for cases of general illumination several points have to be considered in order to obtain an average value, and so a considerable amount of work is entailed.

The above method has many limitations apart from its unwieldiness for general problems. Primarily, the

method came into existence when small light sources were used in direct reflectors, but when other systems of lighting, such as indirect and semi-indirect, are considered, difficulty is at once experienced, as, owing to all or a large percentage of the light not reaching the plane of work directly, the illumination cannot be calculated in the above manner. Thus, to apply the method to an indirect-lighting scheme, further elaboration is necessary, such as calculating the average illumination on the ceiling, and then, by considering the reflection power of the ceiling and its height above the plane of work, an estimate is made of the illumination that will be obtained. This is, in any event, a matter of extreme difficulty.

Even in direct-lighting systems discrepancies arise owing to the fact that where a large amount of light is "spilt" on to the walls the light contributed by reflection becomes appreciable (especially with light-coloured walls) and can no longer be neglected in calculating the results.

There is yet another drawback to this method, in that it is analytical and not constructive. It does not directly indicate the size of illuminant to be employed to obtain a specific result, the size having to be found by trial and error, various sizes and mounting heights being assumed and analysed until one is found to produce the desired degree of illumination.

The designer also has to have available polar curves of light distribution for the particular fittings employed.

In an endeavour to shorten the numerous calculations involved, and to develop a more general method that could be also readily applied to indirect-lighting problems, the electrical illuminating engineer adopted a quicker but rather more approximate means known as the "watts per square foot" method.

All illumination schemes were divided into four classes, these being:—

(1) Direct lighting
(2) Semi-indirect lighting
(3) Diffused lighting
(4) Indirect lighting,

and the wattage required per square foot of floor area, to produce an illumination of one foot-candle under each of these forms of illumination, taken as a calculation constant. The above data naturally has to be stated within certain limits; for example, in one set of tables, the values of 0.16, 0.2, 0.25 and 0.25 watts per square foot are given for the respective systems of lighting; gasfilled lamps being employed on mounting heights between 10 and 15 feet. It is assumed that the units are mounted at their correct "height-spacing" ratios.

This method reduces the calculation down to simply multiplying three quantities together, as follows:—

Total wattage per room = floor area in square feet × required foot-candles × constant.

Knowing the number of points employed, the wattage per point can be readily calculated.

At first sight it may appear that the desired simple method of solution has been attained, but a few moments' examination will show that the method contains many inaccuracies and is too general for very satisfactory work.

It should be noted that no allowance is made for the differences in the reflective powers of various walls and ceilings, and these will modify the results under all the systems, especially in the cases of indirect and semi-indirect lighting.

The effect of changing the mounting height has also been largely neglected.

Finally, the light output of a lamp is taken as being proportional to the wattage and the same for all voltages, which is incorrect. The light output of a lamp of any particular wattage is different according to whether it is for high voltage (200–260 volts) or low voltage (100–130 volts), also the light output per watt varies according to the size of lamp used. The variation in light output efficiency of lamps of various wattages of both the high and low voltage type is shown in the graph given in Fig. 2.

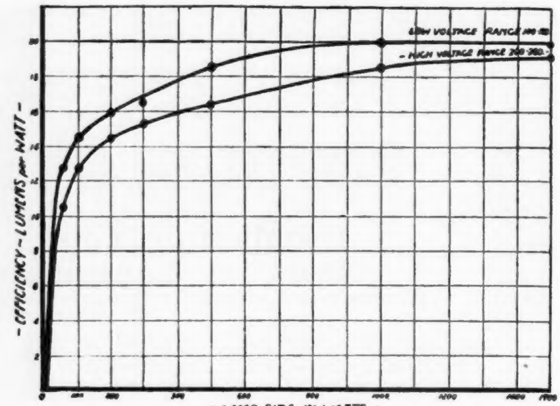


FIG. 2.—Relation between Efficiency (lumens per watt) and Consumption of Lamps in watts.

For the sake of illustration, let us assume our calculation shows that 2,400 watts are required for the illumination of a certain room. The equipment may consist of 24, 16, 12 or 8 units of 100, 150, 200 and 300 watts respectively. Remembering that we have two possible ranges of voltage, and taking the first-mentioned arrangement (24 100-watt lamps) on 200 volts as our 100 per cent. basis, the following table shows the percentage light generated in each case:—

Size and Number of Units used.		Supply Voltage. 100-130.	200-260.
Twenty-four	100-watt units	114	100
Sixteen	150 ,,	119	104
Twelve	200 ,,	124	114
Eight	300 ,,	129	119

It will be seen that we may actually get a variation between 100 and 129 for our light output due to these two causes alone.

It may be generally stated that this method can really only be successfully applied as a guide to the *minimum* wattage required to ensure a certain intensity of illumination; the constants being so chosen as to allow for liberal losses and for high voltage systems, but does not enable the designer to prepare an installation for a given interior so as to produce a specified average intensity. Clearly the ability to design a system for a specific intensity of illumination not only enables the designer to face his problems with confidence, but also ensures maximum efficiency, a matter of great importance to contractor and purchaser.

It was with the object of overcoming the above-mentioned inaccuracies, and yet keeping the calculations from becoming too laborious, that a large amount of research work has been undertaken by illuminating engineers in recent years. As a result of such research the "lumen method" has been evolved, and, as will be seen, the various factors have been carefully studied and allowed for and calculations minimized by means of suitable tables.

(*To be continued.*)

The Electrical Association for Women

The Electrical Association for Women is interesting itself in the problems arising from the passing of the Electricity (Supply) Act, 1926. One of the chief points to which attention is drawn is that a supply of electricity is in itself of little avail if the house is not already provided with facilities for using this new power—in other words, there must be an adequate number of outlets. Accordingly the Association has decided to draw up a National Women's Specification bearing on this point. Members are then proposing to visit housing estates in order to ascertain what arrangements are being made, and a suitable "questionnaire" has been provided for their use.

There will also be deputations to architects, builders, housing authorities, and others interested. We hope that in their scheme they will ensure that adequate provision is made for lighting, which has sometimes been neglected in the desire to encourage the use of heating and power.

The Electrical Trades Benevolent Institution

As a large number of our readers are both directly, as well as indirectly, interested in the electrical industry, we think it not inopportune to call their attention to the excellent work being done by the Electrical Trades Benevolent Institution, which has the following important objects:—

> To grant pensions, dispense temporary relief, grant loans, and otherwise assist deserving and necessitous persons of either sex who have been engaged in the Electrical Trade in any of the following capacities, or their dependents: Manufacturers, directors of limited companies, wholesalers, retailers, contractors, dealers, commercial and sales managers, secretaries, clerks, salesmen, travellers, canvassers, counter hands, buyers, works managers, works superintendents, designers, draughtsmen and tracers, inspectors, supervising electricians, staff warehousemen; editors, managers, canvassers, clerical staff of the electrical and allied press; and others engaged regularly in electrical occupations including electricity supply undertakings; but excluding working foremen, charge-hands, mechanics, wiremen, and all employees engaged in actual manufacture or repair; employees who are engaged chiefly as salesmen or in clerical capacities are, however, eligible, even if they occasionally assist in repairs.

We are informed that the legitimate demands on the funds of this institution have doubled in 1927 those of 1926, while those in 1926 were nearly twice those in 1925, and, in spite of this, every case entitled to relief has been satisfactorily dealt with in a strictly private and helpful manner, by the hard-working committee, with the assistance of Mr. F. B. O. Hawes, the experienced Hon. Secretary.

The last balance-sheet shows the total expenditure was, for all administration expenses, only £326 7s. for dealing with all the cases, and the income was £8,651 3s. 6d., so that it may be justly said "all that is contributed goes to the benefit of those who are unfortunately in need."

We cannot too warmly commend this fund to those working in the electrical industry, who can, for quite nominal subscriptions, become Members or Associates with definite privileges; while we hope employers, whether firms or companies, in the electrical or allied industries will, by donations, subscriptions, etc., help to place the funds on a secure basis for granting not only relief of a temporary nature but also pensions.

The following are recent cases typical of many arising from day to day concerning people in very diverse walks in life:—

No. 532

> Having been connected with the electrical industry for over thirty years is now suffering from failing eyesight, the sight of one eye having completely gone.
>
> The E.T.B.I. Grants have helped him to obtain the special spectacles which were necessary, and provide him with small income until he is able to obtain employment.

No. 536

> Has been connected with the electrical industry for many years, but owing to a paralytic stroke, which has left his left hand practically useless, he is unable to fully support his wife and children.
>
> Grants from the E.T.B.I. help to pay the rent and obtain necessary food.

No. 557

> After having been connected with the electrical industry for over thirty years, he developed chronic trouble and was unable to continue his work.
>
> The E.T.B.I. Grants helped to provide the necessary nourishment and medical treatment required.

No. 600

> An electrical contractor of more than twenty years' standing, died, leaving a wife and five children totally unprovided for.
>
> Grants from the E.T.B.I. augment the small amounts earned by two of the children, and so help to meet the necessary expenses.

The Headquarters of the Electrical Trades Benevolent Institution is 36/38, Kingsway, London, W.C.2, and there are several local branches throughout Great Britain actively at work. Any contributions at this critical time will be gladly received by the Hon. Secretary at the above address.

INCOME AND EXPENDITURE ACCOUNT
FOR THE YEAR ENDED 31st DECEMBER, 1926.

	£	s.	d.
To Printing, Stationery and Postage	130	4	11
,, Office and Clerical Expenses	154	0	6
,, Travelling Expenses	11	19	7
,, Transfer Fee	24	17	6
,, Trustee's Fee	5	5	0
,, Balance	8,324	16	0
	£8,651	3	6

We have examined the above Balance Sheet, dated 31st December, 1926, with the Books and Vouchers of the Institution, and having obtained all the information and explanations we have required, we are of opinion that such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Institution's affairs, according to the best of our information and the explanations given to us and as shown by the books of the Institution.

We have received certificates from Bankers in verification of the Investments and Cash.

(Signed) PRICE, WATERHOUSE & CO.
3, Frederick's Place, Old Jewry, E.C.2.
13th May, 1927.

	£	s.	d.	£	s.	d.
By Subscriptions and Donations—						
Resulting from the Annual Festival	6,912	7	5			
Less Expenses	63	7	4			
				6,849	0	1
,, Contributions, resulting from Ballot and Dance, held at Newcastle-on-Tyne ...				177	10	9
,, Contribution from Engineers' Ball				65	0	0
,, Contribution from Executors of the late late A. P. Lundberg				50	0	0
,, Other Subscriptions:—						
Life Members	21	0	0			
Members	74	7	6			
Subscribers	63	13	6			
				159	1	0
,, Other Donations				114	10	9
,, Income Tax Recoverable ...	127	19	3			
,, Dividends on Investments ...	1,106	1	5			
				1,234	0	8
,, Interest on Deposit				2	0	3
				£8,651	3	6

A Striking Industrial Lighting Installation

The accompanying illustration, for which we are indebted to Messrs. Philips Lamps Ltd., is a good example of modern overhead lighting in factories. A very great advantage of this method is that it leaves a clear view of the entire room, and the light sources, being well out of the direct range of vision, do not offend the eyes. The reflectors serve the double purpose of screening the lamps from the eyes of works and workers, and distributing the light uniformly, and in this case the possibility of glare is still further eliminated by the use of Philips "Argenta" opal bulb lamps. The effect of such lamps within reflectors has one interesting feature—that at a little distance the outlines of the bulb merge with the brightness of the reflecting surface, so that the whole looks like a uniformly bright disc.

According to information supplied, the floor area in the case of this installation was 1,470 square metres—the room being 70 metres long and 21 metres broad. Two hundred and fifty fittings, each equipped with a 150-watt lamp, making 37,500 total watts consumption, were installed. The specific consumption was thus 25 watts per square metre—equivalent, roughly, to $2\frac{1}{2}$ watts per square foot. The resultant illumination averaged 11.8 foot-candles, which should amply suffice for all ordinary forms of industrial work.

Floodlighting in Frankfürt

We are indebted to Messrs. Körting & Mathiesen Electrical Ltd. for the accompanying pleasing illustration, showing an example of the floodlighting which was a main feature of the "Light Festival" held in Frankfürt a/M. last December. The illumination of this Römer façade was effected with a series of Kandem

floodlights, mounted 80 metres away, and consuming in all 6 kw. The main street of Frankfürt was crowded by thousands of people during the spectacle, which served admirably to stimulate local interest in illumination.

Sheffield Illumination Society

The annual social evening arranged in connection with the Sheffield Illumination Society was held at Messrs. Stephenson's Restaurant, Castle Street, Sheffield, on January 20th, when about 100 members and friends spent an enjoyable evening.

Councillor E. R. Minshall (Chairman of the Lighting Committee), who presided, referred to the forthcoming Conference of Public Lighting Engineers, which is to be held in Sheffield this year, and at which Mr. J. F. Colquhoun will become president.

Musical items and whist occupied the remainder of the evening, Councillor Nicholson presenting the prizes at the close.

The next item was a lecture delivered by Mr. G. Sayer, of the Corporation Lighting Department, in the meeting room at the Y.M.C.A., Fargate, on the 13th February, the subject being "A Talk on Lighting Topics."

Mr. Sayer reminded the members of the objects of the Society, which are: (*a*) To arrange visitations to works, etc.; (*b*) to devise means for helping and extending the technical knowledge of its members; (*c*) the submission of papers by members and others, and discussion thereon; (*d*) the delivery of lectures. The lecturer spoke of the lighting in ancient times, and remarked that the earliest record of artificial light being used is about 35,000 years B.C. Turning to modern lighting developments, Mr. Sayer discussed the control of street lamps by time switches and clock controllers, and many interesting points were brought to the notice of the members. Mr. Sayer also spoke on the various kinds of governors used, emphasizing that careful maintenance of lighting plant was most essential if efficiency was to be obtained.

A large number of lantern slides were shown after the lecture, which led to a useful discussion. Mr. J. F. Colquhoun (Lighting Engineer for Sheffield) presided, and thanked the lecturer for his very helpful remarks.

Gas at the British Industries Fair

A Fine Exhibition of Gas Appliances

THE demand for gas appliances is growing by leaps and bounds, and the improvements which are being made in gas cooking, heating, water-heating and lighting appliances are numerous and notable. For these reasons we would recommend every reader to visit the Gas Section at the British Industries Fair, Birmingham, which provides an unequalled opportunity to gain with a minimum of effort a comprehensive idea of the many recent developments.

A Large and Comprehensive Exhibit.—In a space of 16,000 square feet are displayed the latest products of all the well-known makers of gas appliances. The gas industry as a whole is represented in the exhibit of the British Commercial Gas Association, which demonstrates the national importance of coal as nature's storehouse of essential raw materials for many industries. The dye industry is shown to depend for the production of its beautiful tints on the scientific carbonization of coal; and the medical profession is shown as being indebted to the processes of gas manufacture for many of its most valuable drugs and disinfectants—aspirin, phenacetin, saccharine, lysol, and the like. Synthetic perfumes, flavouring essences and photographic chemicals come from the same source. The display may be described as the key to the Gas Section, suggesting as it does the real significance of gaseous fuel in relation to the health, comfort and well-being of the whole community. The slogan of the exhibit, " Use Gas and Let In the Sunshine," is aptly chosen.

The exhibits of the makers of gas appliances indicate that they are very much alive to the necessity of improving, year by year, the quality, finish and efficiency of their appliances.

While it would require a book to describe the individual exhibits, the following notes will give an idea of new tendencies in design in the most commonly used appliances and of new opportunities opening out for the sale of gas-consuming apparatus.

The All-Enamel Cooker.—Although the gas cooker is so well known and is already used by at least 90 per cent. of our population, manufacturers are still endeavouring to make the appliance more labour saving. This year, for the first time at the Fair, there are several examples of " all-enamel " cookers. It will be readily understood how attractive these cookers will be to the housewife, for they can be kept clean with a minimum of effort. Gas cookers have a long life—many from 20 to 30 years—but the recent improvements will create a desire on the part of many of the occupants of the 6,000,000 homes in this country in which gas cookers are already in use to go in for the more up-to-date ones.

Gas Fires.—Gas fires, too, are being improved beyond all recognition. At the Fair the latest designs and finishes are shown—and very beautiful many of them are. Special gas-fire flues—in so many housing schemes replacing costly chimneys—are also exhibited.

Ice from Gas.—The new Public Health (Preservatives in Food) Regulations are now in operation, and the general public is showing a keen interest in domestic refrigerators. Women-folk, however, have a strong objection to motors, valves, and the like in their kitchen. Fortunately there is no necessity to have them, for with the gas-operated (" Electrolux ") refrigerator the housewife has only to light a small gas burner and continuous refrigeration is provided at a cost considerably below that of motor-driven refrigerators. It has no moving parts whatever, and the makers claim that it is " the only refrigerator which does not require a maintenance service."

Lighting.—The latest products of the manufacturers of gas lighting fittings are shown by such well-known firms as the Bland Light Syndicate, William Sugg & Co. Ltd., Lighting Trades Ltd., the Welsbach Lighting Co. Ltd., and Messrs. G. Bray & Co. Ltd. Messrs. Sugg & Co. are showing examples of their lamps and conversion fittings for public lighting, as used in Australia, Ceylon, China, Egypt, India, Japan, New Zealand, Singapore, South Africa and South America, as well as throughout Great Britain and Ireland. The chief feature of the Welsbach exhibit is a lighthouse burner used in conjunction with a lens panel similar in every respect to those now in existence in the important lighthouses around the British Isles. The mantle in use on this burner is said to be the largest in the world and measures 9 inches in height. The burner and mantle in conjunction with the lens apparatus gives the astounding illuminating power of approximately 78,000 British candles. Between this mantle and " the smallest gas mantle in the world," which they also exhibit, is their range of over 100 mantles of different shapes and sizes.

While some of the striking features of the Gas Section of the Fair have been described, it must not be forgotten that the main value of a visit to it consists in the opportunity it affords of seeing, almost at a glance, all the latest and best products of 60 manufacturers of British gas appliances.

In the Fair the large buildings " A " and " A A," and " B " and " B B," with their extensions, are lighted with high-pressure gas lamps, each of 1,000 candle-power. The whole of the cooking for the thousands of visitors is being done by gas. Some idea of the magnitude of this service may be gained from the fact that over 700 waiters and waitresses are being employed.

The Gas Industry in America

During the Convention of the American Gas Association a thoughtful survey of the gas industry in the United States was presented by Mr. Samuel Insull, President of the People's Gas Light and Coke Company, in Chicago. On the whole, the present position is gratifying. The total output of manufactured gas now approaches 500,000 million cubic feet per annum. Gross sales have increased 352 per cent. in 25 years. Total sales per capita have increased more than 70 per cent. in ten years.

These figures should suffice to show that the gas industry is holding its own and continues to develop, notwithstanding the great progress of the electrical industry in America. Mr. Insull strongly advocated closer co-operation between the two industries, which, he said, are not really competitive but should pull together in meeting the requirements of other great industries. When they do come into competition friendly co-operation should uncover the natural line of cleavage between them, on an engineering and economic basis, so that each may do the work it can do best.

One suggestion was that the gas industry might learn from the electrical industry some of the advantages of long-distance transmission. Mr. Insull also suggested the gas industry might adopt the same principle as that underlying charges for electricity—that the consumer who uses the company's service for the greatest number of hours per day is entitled to the lowest rate.

The Value of Heat from Gas Lighting

THE accompanying illustrations will be of interest to illuminating engineers, because the gas lighting installations shown were found to be particularly advantageous on account of the heat given out by the burners.

They are views of sections of the York Cattle Show held in December last, and were taken at 11 o'clock in the evening. Gas has not been used on every occasion for the lighting of this show, and complaints were sometimes made of the coldness of the building by the exhibitors of valuable live stock, some of which actually died. Last December, therefore, the Show Committee decided to revert to gas lighting.

It will be noticed that in one of the illustrations there are pens of poultry, which suffer greatly if exposed to extreme cold. The brilliancy and evenness of the illumination leave little to be desired from the illuminating engineer's point of view.

TRADE NOTES & ANNOUNCEMENTS

AN INDIRECT LIGHTING INSTALLATION IN MANCHESTER.

The large concert hall recently built by Messrs. Lewis's Ltd., the well-known departmental store proprietors, of Manchester, has been equipped with what is probably one of the finest indirect lighting installations in the country.

The building was erected, primarily, as a concert, entertainment and lecture hall, but is utilized occasionally as a showroom. It has a barrel ceiling with a solid dome in the centre, 45 feet in diameter. Both ceiling and dome are deeply coffered, the ceiling and upper parts of the walls are tinted a

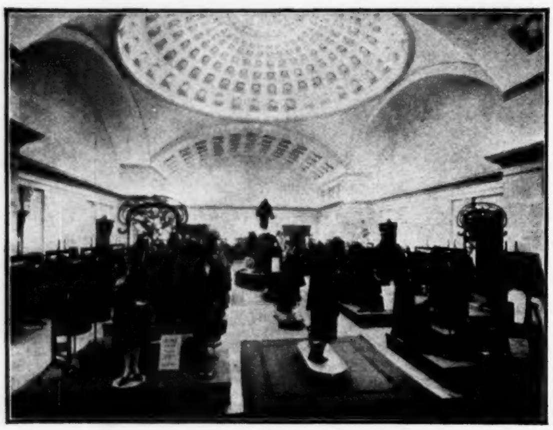


FIG 1.—Concert Hall of Messrs. Lewis's Ltd., Manchester: Showing effect of indirect lighting.

mottled parchment colour in order to blend with the buff-coloured marble with which the lower part of the walls is covered and with the marble columns in front of the entrance lobbies.

The lighting is effected by means of units mounted on brackets fixed in the cornices beneath the main ceiling and dome, the units being of a special type designed and manufactured at the B.T.H. Fittings Factory. This special unit consists of a stainless-steel trough reflector in conjunction with a

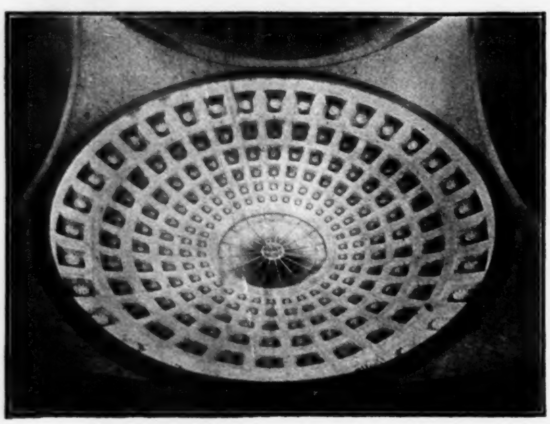


FIG. 2.—A Special View of the Dome, which receives even illumination, such that all details are visible.

Mazda projector-type lamp. It is fitted with a slightly obscured curved glass front, which prevents any streaky effect being produced by the use of a gasfilled lamp in conjunction with a polished reflector. This glass front also acts as a dust cover, and thus facilitates cleaning and maintenance of the installation in good condition.

A total of 160 of these special units is employed for the complete scheme, 96 being concealed in the cornices of the main hall and a further 64 in the cornices at the base of the dome.

The units give a concentrated beam of high intensity, which enables the light to be projected towards and actually past the centre of the dome or ceiling, while at the same time preventing an excess of light on the wall immediately above the unit.

Throughout the concert hall the general effect of the lighting is good, and from a spectacular point of view the dome presents a striking appearance, the details of its intricate design being clearly revealed.

The accompanying illustration, Fig. 1, gives an idea of the general appearance of the building by artificial light. (It should be borne in mind that the installation was designed for a concert hall, but at the time this untouched photograph was taken the room was being used for a special display of furs, a situation which was not taken into consideration at the time the installation was planned.)

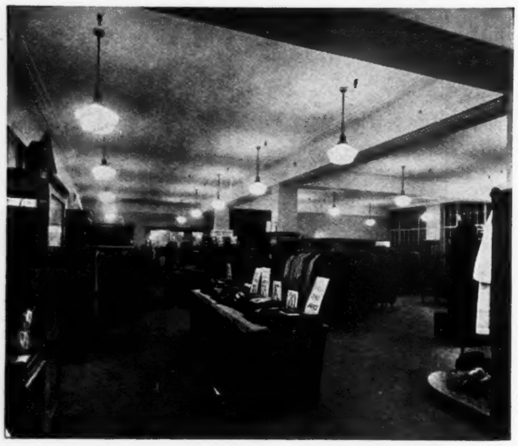
Fig. 2 is a view of the dome, seen from below, showing clearly the evenness of the lighting and depth of relief in the decoration.

In order to prevent a complete section of the building being suddenly plunged into darkness, alternate units are connected to different circuits. This arrangement also permits the general intensity of the lighting to be reduced to half, if required, without placing any local portion of the hall in darkness.

The architects (J. W. Beaumont & Sons, Manchester), the consulting engineers (Henry Lea & Son, Birmingham), and the lighting engineers of the British Thomson-Houston Co. Ltd. all co-operated in the scheme. The actual work of installation was carried out by the electrical staff of Messrs. Lewis's Ltd.

MODERN STORE LIGHTING.

The new extension building of the Civil Service Supply Association, Agar Street, Strand, is of considerable architectural interest, and, with the arcade entrance in the Strand, is in keeping with this old and well-established store.



A feature of the Strand entrance and the various showrooms in the new building is the lighting, carried out by means of Siemens Silvaray Glassware Fittings and Siemens Gasfilled Lamps. The untouched photograph of the second floor gives a good idea of the dignified effect and the high illumination provided, which renders it easy for customers to select their requirements, and for employees to make sales.

The electrical engineers were Rashleigh Phipps & Co. Ltd., 147, Oxford Street, W.1, who are to be congratulated on this installation.

THE 30-AMP. "DIA-CARBONE" ARC LAMP.

In a recent issue we referred to the installation of the new 30-amp. enclosed-flame arcs in Leipzig, which are stated to yield approximately 8,000 candle-power each, and operate at about 0.21 watt per candle-power (mean hemispherical). Another feature, apart from the high candle-power, is the length of time, 120 hours, for which these lamps will operate on a single pair of carbons.

The accompanying illustration (Fig. 1), which is furnished by Messrs. Körting & Mathiesen Electrical Ltd., shows a type of these lamps equipped with an upper reflector which has the effect of partially screening the source and directing the majority of the light downwards. As, however, the globe is of a diffusing character, there is still sufficient light emitted sideways and upwards to obviate the formation of a "shadow line" on the faces of adjacent buildings, etc. In view of the high candle-power, such lamps should be mounted at a considerable height, at least 60 feet. Bearing in mind their considerable weight (about 40 kg.), special attention has been devoted to methods of support.

These lamps are usually burned two in series on 110 volts, or four in series on 220 volts, and a substitution resistance, which automatically takes the place of the lamp in the event of a failure, is therefore necessary. This resistance, which is shown in Fig. 2, is assembled in quite a neat and unobtrusive form.

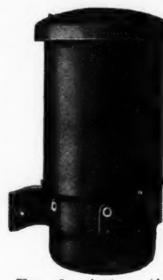


FIG. 2.—Automatic Substitution Resistance.

FIG. 1.—A type of the new 30-amp. "Dia-Carbone" Arc Lamp, with upper reflector screening the direct rays and concentrating most of the light downwards.

CONTRACTS CLOSED.

The following contracts are announced :—

METRO-VICK SUPPLIES LTD. :—

Southern Railway; part contract for supply of Cosmos incandescent electric lamps for period March 1st to August 31st, 1928.

Metropolitan Borough of Islington; contract for the supply of electrical sundries for the period of 12 months from April 1st, 1928, to March 31st, 1929.

ERRATUM.

Our attention has been drawn to a slight clerical error on page 36 in our issue of January, 1928, in the description of the three-ply illuminating glassware supplied by the Wholesale Fittings Co. Ltd. The 12-inch type was said to be intended for a 20-watt gas-filled lamp; obviously this figure should have been 200 watts.

INDEX (March, 1928).

SPECIAL INFORMATION.

THE ILLUMINATING ENGINEER (the Journal of GOOD LIGHTING) was founded in January, 1908, and has thus been in existence for twenty years.

SINCE the year 1909, when the Illuminating Engineering Society was founded in London, it has been the official organ of the Society.

IT is *the only journal in this country exclusively devoted to Lighting by all Illuminants.*

IT receives the assistance of contributors who are leading experts on illumination in this country and abroad. Foreign Notes and News will be a speciality, and correspondents have been appointed in all the chief cities of the world.

THE Journal contains *first-hand and authoritative information on all aspects of lighting;* it has also been improved and extended by the inclusion of a *Popular and Trade Section* containing special articles of interest to contractors, gas and electric supply companies, Government Departments and members of the Public.

DISCUSSIONS before the Illuminating Engineering Society which are reproduced in this Journal are participated in alike by experts on illumination and *users of light*, whose co-operation is specially invited.

Good Lighting is of interest to everyone. The Journal is read by engineers, architects, medical men, factory inspectors, managers of factories, educational authorities, public lighting authorities, and large users of light of all kinds.

BESIDES being issued to all members of the Illuminating Engineering Society, the Journal has an independent circulation amongst people interested in lighting in all parts of the world. The new and extended form of the Journal should result in a continual and rapid increase in circulation.

Every reader of THE ILLUMINATING ENGINEER, the Journal of GOOD LIGHTING, *is interested in illumination, and is a possible purchaser of lamps and lighting appliances. Gas and Electricity Supply Undertakings likewise benefit by the movement for Better Lighting, with which the Journal is associated, and which stimulates the demand for all illuminants.*